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Military Systems Design

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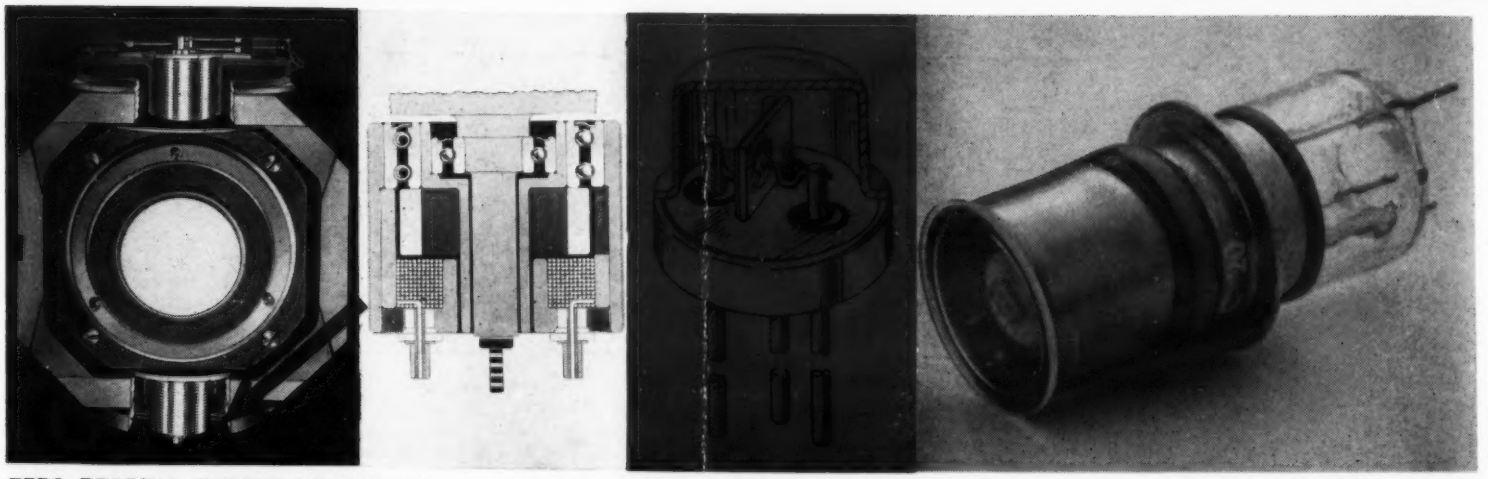

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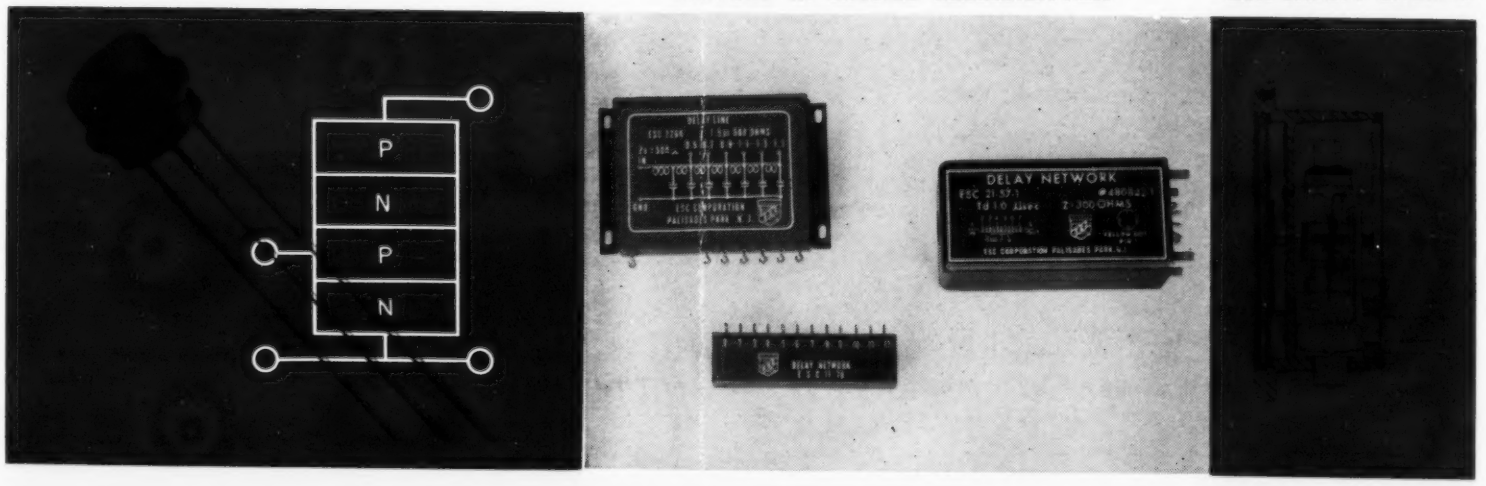

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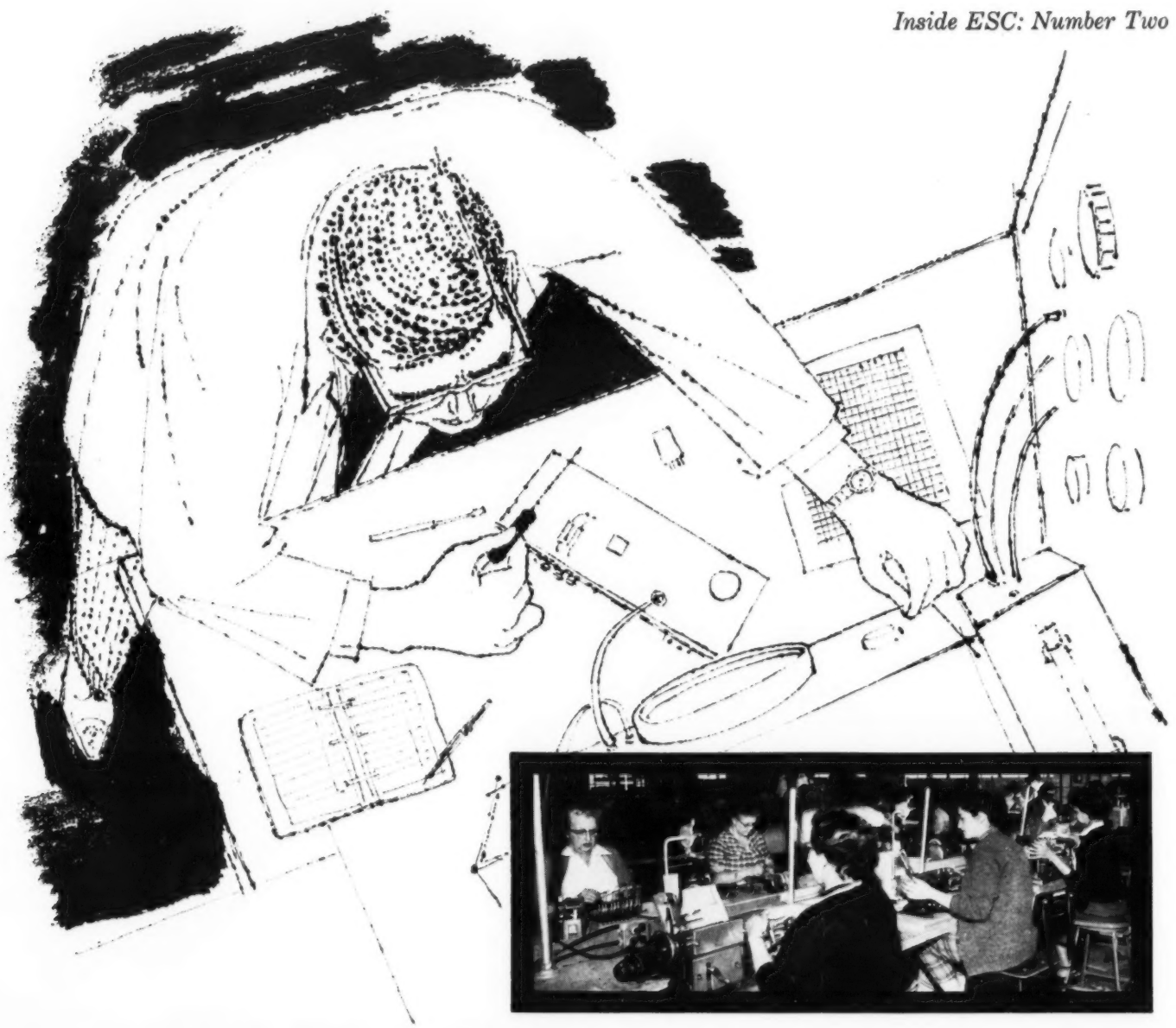

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MILITARY SYSTEMS DESIGN

formerly MILITARY AUTOMATION

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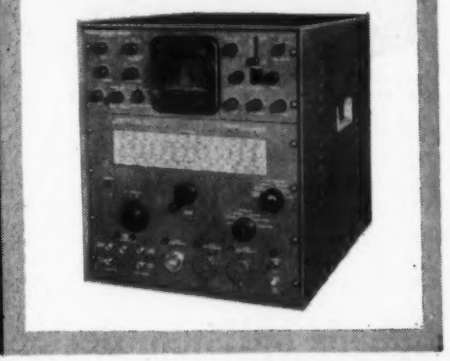

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MSD editorial

Educational Help for Technology

SOLID-STATE devices, parametric amplifiers and increased concern with reliability were stressed in the military developments presented at the recent IRE Convention. Military system activity now definitely appears to have emerged from the Sputnik-induced shock and re-orientation phases, which were largely responsible for last year's doldrums. Military Systems planning is showing rapid progress in miniaturization, environmental ruggedness, and in compatibility with human factors.

Interest shown in developments and exhibits by the large crowd of registrants was encouraging to the exhibitors, and to all who study convention crowds as an indication of business conditions to come. A number of exhibitors remarked that the questions asked by visitors showed that they were generally well informed as to the basic uses of their products, in contrast with the "What's this?" attitude which has predominated in previous years. This testimony is evidence that informed personnel are anxious to get more information on the capabilities of the products available now and in the near future, for use in Military systems.

Moreover, the rate at which technological development is unfolding continues to accelerate. In the field of semiconductors alone, new materials capable of operating at much higher temperatures will extend the uses of these devices and tremendously affect our missile and space craft capabilities.

Although Russia initially took the lead in missile tonnage, our ability to cram more performance into each cube-pound may be equally significant. In the near future, more sophisticated control and instrumentation systems can be expected on the Sputniks, just as certainly as the load-lifting abilities of our rockets are being improved.

Our present generation of scientists and engineers is a priceless asset in this contest. Every opportunity should be utilized to extend their training to new levels, to keep them abreast of new developments, and to utilize their retirement years. An adult scientific education movement, coordinated by a national association of universities, and providing professionally recognized credits, would implement and stimulate the "continuing growth" that is needed. It should also provide many of the qualified teachers at High-school and Junior College levels which are needed more acutely every year.

At the present, cooperative extension courses provide this type of in-service training for comparatively

few persons. It is our belief that the tremendous potential of educational television could give the new and vitalizing dimension to technical correspondence courses, providing the training channels our technology needs.

LETTERS

Editor, MSD:

I read with interest the article on Simulators on page 6, Jan-Feb MILITARY SYSTEMS DESIGN. The difficulties you have described in the use and programming of function generators have plagued the simulator and general analog computer field for years. The Electrol Model 100 Diode Function Generator, featuring punched card programming which provides a permanent library of functions for repeated use, was developed to overcome these limitations.

R. A. Sinker, President
Electrol, Inc.,
Los Angeles, Calif.

Although descriptive information enclosed with your welcome letter arrived too late for inclusion with this issue, we are pleased to mention your data sheet on this timely development in the New Literature department of this issue.

Editor, MSD:

Articles such as Captain Callahan's in the Jan-Feb issue of MILITARY SYSTEMS DESIGN are of inestimable value. He points out the value of trainers for training aviators which indicates that future Space training problems may also benefit in the same manner. Current literature indicates that no efforts are being made or considered for training of personnel in systems potentially more complex and dangerous than aircraft.

John Huson, Staff Engineer
Special Projects,
Chrysler Corporation,
Detroit, Mich.

We were pleased to relay your comment to Capt. Callahan, whose comment follows:

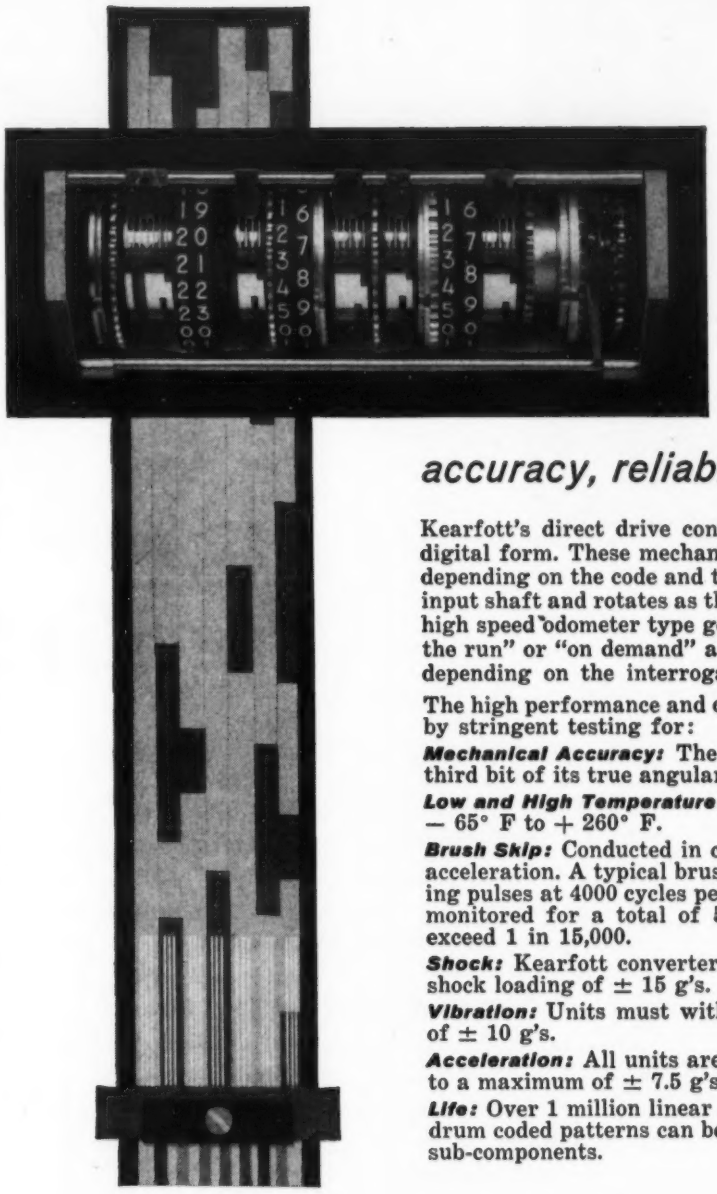
Editor, MSD:

We are very pleased with the article in the Jan-Feb issue of MILITARY SYSTEMS DESIGN on the Navy's flight trainer program. In regard to training devices for manned missiles or space craft, I can report that such are in the works. We feel that simulators will have an increasingly important function as orbital and space programs mature. One project will be initiated during the next fiscal year, and a number of others are in the planning stage.

I am very highly impressed with your magazine and feel that it can contribute to our work.

Edw. C. Callahan, CAPT. USN
Command Officer and Director
US Naval Training Device Center.

MILITARY SYSTEMS DESIGN will report on this new development in training simulators at the earliest opportunity.



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Kearfott's direct drive converters translate shaft rotation into electrical and visual digital form. These mechanically positioned units consist of coded drums, the number depending on the code and total count. The first, or units drum, connects directly to the input shaft and rotates as the shaft turns. On models where more than one drum is used, high speed odometer type gearing provides interconnection. All models can be read "on the run" or "on demand" and all tracks may produce simultaneous or serial readings, depending on the interrogating pulse.

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Brush Skip: Conducted in conjunction with tests for temperature, vibration, shock and acceleration. A typical brush skip test employs 200 μsec., 23V DC amplitude interrogating pulses at 4000 cycles per second. With the shaft rotating, each output drum track is monitored for a total of 500,000 pulses, in which "lost" counts or "skips" will not exceed 1 in 15,000.

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Code (1)	B.D.	B.D.	B.D.	B.D.	B.D.	B.D.	C.B. (Gray)
No. of Drums	1	1	2	3	3	4	5
Range	0 to 84 in 348.5° of arc. 11.5° dead spot coded O	−19 to 0 to + 19	0 to 359	(+) 0 to (+) 999 (−) 999 to (−) 0	0 to 359.9	0 to 359.9	0-32,768 (2^{15})
Bits per Revolution	85	39	40	20	40	40	16
Revolutions for Total Range	1	1	9	100	90	90	2,048
Volts D.C.	23	12	23	23	23	23	10.5
Current (ma.)	20	20	20	20	20	20	20
Inertia (gm. cm.²) (2)	158	48	104	28	158	100	20
Unit Diameter (in.)	2⅛	1¾	1 15/16	1 7/16	1 15/16	1.875	1 7/16
Unit Length (in.)	31/32	1 1/16	1-43/64	1 15/16	2 1/16	2.8125	3
Life (3)	10^6 revolutions or 10^3 hours						
Static Torque (in.-oz.) (4)	0.5	0.1	1.0	.5	1.0	1.0	2 (break) 1 (running)
Weight (oz.)	5	3.5	5.75	4	7.75	6.5	5
Maximum Speed (RPM)	1100	250	300	400	300	700	600
Dielectric (Volts DC)	500	500	500	500	500	500	500

(1) B.D. (Binary Decimal), C.B. (Cyclic Binary).
(2) Inertia measured at maximum trip.
(3) Under recommended conditions.
(4) At room temperature.

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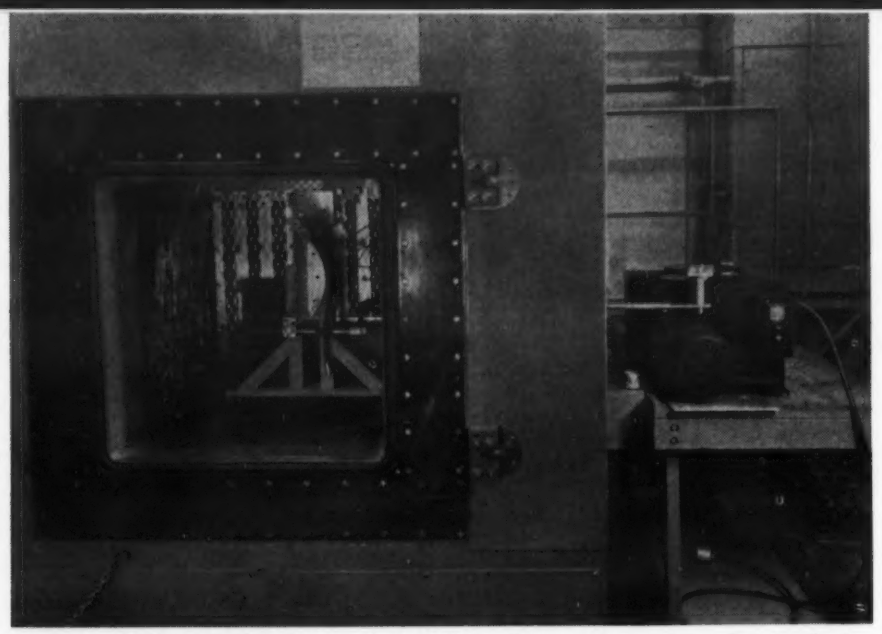

FIG. 1. FLEXING TEST under simulated conditions of use gives clue to elusive coaxial cable failures in flight.

The most controversial topic of our present American industry is reliability. An unknown factor less than a decade ago, it has almost over night become the top slogan for the promoter, the key word for the manufacturer and the nightmare of the engineer. It should be of interest to note that, so far, only a few fields of engineering exist which offer clues for the prediction of reliability. One of them is the area of environmental testing.

B. J. FORSHER

Realistic Approach in En

ENVIRONMENTAL TESTING is the study of the behavior of components, instruments or machinery under extreme and severe conditions. By establishing that malfunction or failure of a unit occurs under certain extreme situations, it may be possible to redesign and improve this item, and simultaneously improve its reliability. For this reason the normally well-performing specimen is tortured under various conditions such as extreme cold, extreme heat, shock, vibration, humidity, sandblast and other environmental stresses to determine when and how it fails. Uninitiated bystanders may gain the impression that environmental testing is the art of ruining perfectly good products under odd conditions. However, a higher goal is set by the environmental test engineer than sheer destruction.

Simulation Requirements

The precise requirements of reliable testing present formidable problems to every test engineer. One of these problems is the fair simulation of the environment.

One must always take into consideration how the component, unit or system is used in respect to adjacent hardware. If it is mounted, for instance, in a hanging manner, it must be tested so. If in actual use it is confined in a compartment with little or no air circulation it must be tested so.

Other problems are the manner in which simulation is achieved, and a determination of the relationships between time under accelerated life tests and that under actual life usage. This is equally as important to movie camera, bicycle or car producers as to the manufacturer of airplanes, missiles and radar. Considerable research is under way to collect data which will tie the environmental laboratory tests to the life expectancy of a product. These studies require extensive and accurate instrumentation.

Mr. Bruno J. Forsher, Environmental Test Engineer for systems components with the Hughes Aircraft Weapons Systems Development Laboratories, holds a degree in Mechanical Engineering from the University of Vienna, Austria. The accompanying article is a condensation of a lecture delivered at the Fourth International Automation Exposition, New York, N. Y.

Collection of Realistic Test Data

However, the most important of all testing aspects is the collection of realistic test data under environmental laboratory conditions. Most engineers who are unfamiliar with our type of work cannot appreciate these difficulties. As a rule they are too preoccupied with their own problems to analyze the difficulties of the task, when they come to the environmental laboratory and say: "Just put this thing into the oven and find why it always konks out as soon as the airplane hits 30,000 feet altitude." These testing problems generally can be classified under one or more of the following challenges to our experience, knowhow and ingenuity:

1. The measurement devices used for the environmental test must be selected, designed and applied in such a manner that the extremes created by the environmental test facility do not affect the accuracy of instrument performance, even in cases where the measuring device is in close proximity to the test specimen.
2. The selection of the test parameters must be restricted by the test engineer to a reasonable but adequate number so that the data collected is meaningful and conclusive. Test parameters are not always obvious in technical problems.
3. The test accuracy desired must be reconciled with the accuracy of available test instruments and with available facilities and budgets.

Typical Testing Projects

In the following typical test setups selected from the Physical and Electrical Test Section of the Hughes Aircraft R. & D. Labs., the problem presented to the environmental testing laboratory is stated first, followed by a discussion of the test parameters, a description of the instrumentation and a brief summary of the test results.

Problem 1. Flexing of a Coaxial Cable

This test (Fig. 1) was suggested by our flight group engineer who suspected that the flexing of a coaxial cable during flight caused a change of characteristic impedance which had not been discovered during a previous environmental test in which the specimen was stationary. We were asked to investigate the cause of failure. I decided that the following test parameters could possibly be of influence:

1. *The rate of stroke.* The associated equipment moved the cable at a constant rate of about 3 cps. This was duplicated by our actuating mechanism, driven by a variable speed motor.
2. *The length of the stroke.* Although a variable length of stroke was possible the maximum stroke, which occurred most frequently under operation, was selected for the test setup.
3. *The bending radius of the cable* also appeared to be variable. We calculated the average curvature, reached at the end of the stroke from a straight line, but also arranged to introduce smaller or larger radii should experimentation fail to yield other clues.
4. *Temperature extremes.* We had to accept the limits offered by the available test chamber although advised to try wider temperature ranges. The lowest temperature reached was —55°C;

FIG. 2. VIBRATION TEST setup of electronic equipment rack for low frequency vibration test.

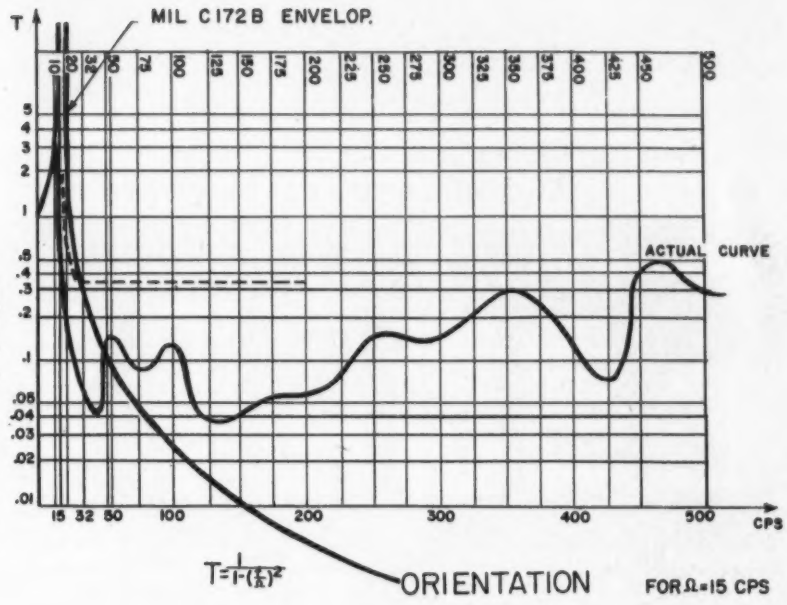

FIG. 3. THEORETICAL and actual transmission curves show effect of damping which diminishes resonance effect but also impairs isolation at higher frequencies.

in Environmental Testing

the highest, 75°C. Temperature stabilization was recorded by the chamber dry bulb instruments and double-checked with thermocouples. Since it was considered to be without influence, altitude simulation was not attempted.

5. *Electrical characteristics.* A wave guide VSWR comparimeter setup was used to study the impedance match and other microwave characteristics of the cable.

6. *Time.* We are usually inclined to overlook this important variable. In this case, the rate of temperature change, $\Delta T/\Delta t$, (temperature shock), proved the greatest factor contributing to failure.

The most difficult part of the instrumentation was the stroke actuation inside the chamber, which had to be closed during the test cycle, of course. We solved the problem by using a long push rod guided by two bearing bushings through one of the side port holes of the chamber (Fig. 1). After a lengthy test it was proven that flexing of this coaxial cable under a stabilized temperature did not effect the performance of the test specimen. This confirmed our previous tests. However, we also found that flexing of the cable under rapidly changing temperature conditions, as experienced under actual flight conditions, *did* cause a failure.

Problem 2. Vibration Isolation Performance of an Electrical Equipment Rack used with Airborne Equipment

As a rule, the average electronic component is too sensitive to withstand vibration or shock for any reasonable length of time. It is standard practice to protect electronic gear by interposing properly selected vibration isolators between the black box cluster and the vibrating airframe. The trend of the past few years has been to crowd more and more electric units into each equipment rack. For this reason, vibration isolation problems and the techniques of vibration isolation performance testing have greatly increased in complexity.

Physics of Vibrating Systems

A short review of vibration isolator philosophy may be in order to point up the signifiance of the test parameters used.

Essentially the phenomena of vibration is linked to three basic ingredients: Mass, spring force and damping. Resonance, a violent manifestation of vibration, is achieved when a particular and discrete relation of these three elements exists. The mathematical evaluation of vibration is quite complicated if all three parameters are included in the calculation. But in run-of-the-mill vibration isolators, damping influence is relatively minor and can be neglected.

The remaining two elements display a much more simplified mathematical picture. The well known formula for a resonance or natural frequency: $f_o = 1/2\pi\sqrt{k/m}$ indicates in simple terms the period (cycles per second) of a resonant frequency for a mass m placed on a (massless) spring of stiffness k. Considering the vibration isolator, the mass is represented by the weight of the electronic units and their mounting provision. Dependent on this weight, a corresponding mechanical coil spring (with little mass of its own) can provide this resonance for a selected low frequency, for example 15 cps.

Importance of Low Resonant Frequency

Our aim in isolating a protected package is to minimize the motion of the airframe which penetrates through the isolator. Our test procedure will obviously be to measure the motion (double amplitude) or force of a constant displacement vibrator on which our test specimen is placed and also to measure and compare the motion of the vibration-isolated part of the test setup (Fig. 2).

The best mode of comparison of forced vibration to isolated vibration is the ratio of either isolated excursion to forced double amplitude, or the ratio of isolated-acceleration force over forced-acceleration force. It should be understood that for pure harmonic motion, generally applied for this type of test, a simple, mathematical relationship between displacement and acceleration does exist. The ratio is known by the term "transmissibility" and its mathematical formula can be reduced to

$$T = y/a = 1/[1 - (f/f_o)^2]$$

Before becoming excited about the beautiful simplicity of this expression, let us be reminded that it applies only for cases where damping can be neglected. The symbol f_o applies to the resonant frequency of the system (fully loaded isolation rack) while f indicates any variable test or forcing frequency within the applicable frequency spectrum.

From this expression it is obvious that as long as the forcing frequency remains below the resonant frequency, the transmissibility will be larger than 1; also when f_o equals f, the value of T becomes infinity. However, for larger f's, the value of T declines rapidly, meaning that isolation has set in. Therefore, the lower the resonant frequency of the isolation system, the larger will be the frequency spectrum where effective isolation can be achieved. And the beautiful aspect of this theory, is that the higher the forced frequency relative to the natural frequency f_o becomes, the smaller the transmissibility appears to become; hence, the better the isolation of the system.

The reason why this theory does not work in practice is that no vibration isolator is free from damping. This is a blessing in disguise as otherwise,

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Input Power (total) 3.8 watts Stall Torque .15 oz in min. .20 oz in nom. Max. Weight 29 gms.	Input Power (total) 5.6 watts Stall Torque .3 oz in min. No Load Speed 6500 rpm min.	Generator Input Voltage 10 v Output Voltage 0.13 v/1000 rpm max.	Output Power 4.0 watts No Load Speed 20,000 rpm Input Voltage 28 v DC	Linearity .5% Null E at EZ .015 v Phase Shift 15 deg. lead	Accuracy 7' error max. Null 30 mv max. Phase Shift 8.5 deg. lead	Accuracy 30' max. error spread Torque Gradient 2200 mg-mm/deg. Input Power .54 watts	Accuracy 7' error max. Null 30 mv max. Phase Shift 8.5 deg. lead	Accuracy 7' error max. Null 30 mv max. Phase Shift 9 deg. lead	Accuracy 7' error max. Null 30 mv max. Phase Shift 11 deg. lead

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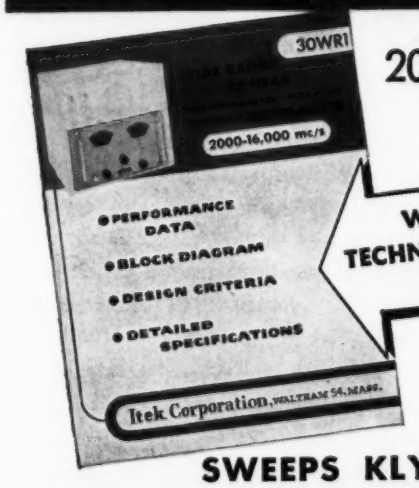

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when the forced frequency matched the resonant frequency, an infinite excursion would be produced which surely would wreck our installation. Because of damping, we can control our amplification factor but we pay for this control in the higher frequency range, where isolation is not as good as the formula would indicate. For this reason, arithmetical evaluation of isolation performance is only possible within a relatively confined area of the total spectrum and needs double-checking by experiments and tests.

A plotted transmissibility-frequency curve will quickly discover fragile electrical units or defective isolators. There is hardly another field of testing where careful measurement and adequate data collection can so improve the product and protect uncounted sums of development engineering funds.

Typical differences between theoretical and practical transmissibility characteristics are clearly shown in Fig. 3 which shows two curves within the confined spectrum of frequencies between 5 and 500 cps. In this graph we may see distinctly that for frequencies below 50 cps the actual T curve remains below the theoretical graph, offering a better than theoretical isolation performance. However, we see that the actual curve intersects the theoretical line at about 55 cps, and remains above this curve for all higher frequencies.

The challenge of space travel and space craft development is confronting the environmental test engineer daily with new problems. Environments having natures never before simulated are now being explored. Every new bit of information received from satellite firings will eventually show up in the form of demands for new, different and closer tolerance simulations. To do our job, we must rely on accurate and reliable measurements which only well designed and carefully fabricated instruments can yield.

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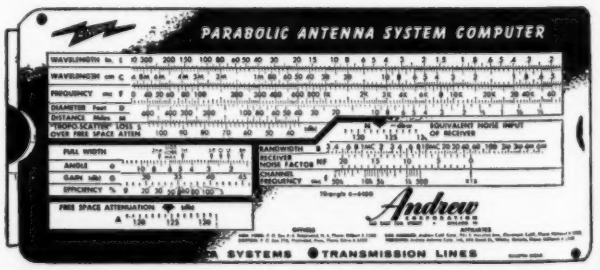

Corporation computer. (*Parabolic Antenna System Computer with Transmission Line & Waveguide Selector on reverse side; 9" long, plasticized cardboard. —Andrew Corporation 363 East 75th St., Chicago 19, Ill.*)

For this literature circle 71 on inquiry card.

TUNED HYBRIDS AS FILTERS

TUNABLE band-pass and band-reject filters, of a new design based on the wide-band tuned hybrid principle, act as single- or dual-channel preselectors or rejectors tunable over a wide range by calibrated controls.

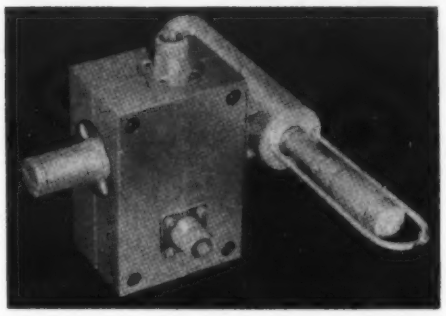

FIG. 3. TUNABLE REJECTION Filter for 2-4 KMC band.

Hybrid Operation

The basic principle of the wide-band coaxial hybrid is illustrated in Fig. 1. Normally, planes P_1 and P_2 are terminated in matched loads ($R = Z_0$). Power injected at the input divides equally betyeen L_1 and L_2 and is absorbed in the loads at planes P_1 and P_2. No power enters the output line since its terminals 1 and 2 are at the same potential. If, however, planes P_1 and P_2 are terminated with open circuits as shown in Fig. 1, then all power would be reflected back to the input, and again no power would be transferred out of the output; both the incident and reflected waves into and out of lines 1 and 2 keep output terminals 1 and 2 at equal potentials.

Single Channel Tunable Filter

In a single-channel reject filter (Fig. 2) lines L_1 and L_2 are the same length but plane P_1 has been terminated in a short circuiting strap which also forms a coupling element between the Line$_1$ and a tunable resonant cavity C_1.

For frequencies at which C_1 is off resonance, there will be full transmission to the output since the reflected waves from lines L_1 and L_2 will be 180° out of phase with one another and their voltages will add across the output terminals 1 and 2. If the cavity is tuned to resonance the short-circuiting strap at plane P_1 will, electrically, be removed and lines L_1 and L_2 will both reflect in-phase voltages at the output terminals 1 and 2. All power will then be reflected back to the input.

Single Channel Band-Pass Filter

If both lines L_1 and L_2 are made equal as in Fig. 2, but both are terminated in short-circuiting straps at planes P_1 and P_2; at off-resonance frequencies, the voltages reflected from L_1 and L_2 will be in phase at the output terminals 1 and 2, to give no output voltage. At the resonant frequency for C_1, however, line L_1 will be electrically "open" at plane P_1 and there will be full transmission through to the output.

Experimental Results

An experimental tunable band-rejection filter for the 2 kmc to 4 kmc frequency range has been built under a crash program which allowed no time for component-by-component refinement (Fig. 3). Although its typical performance is believed significantly less than could be achieved using a well-balanced hybrid in which cumulative reflections were minimized, analysis indicates that rejections in the order of 60 to 70 db should be achievable over a 2-1 range of frequencies. (*From 5-page technical paper which also describes the design of dual channel tuned filters, by Glyn Bostick and Arthur Willbrand, Radar Design Corporation, P. O. Box 38, Pickard Drive, Syracuse 11, N. Y.*)

For this literature circle **72** on inquiry card.

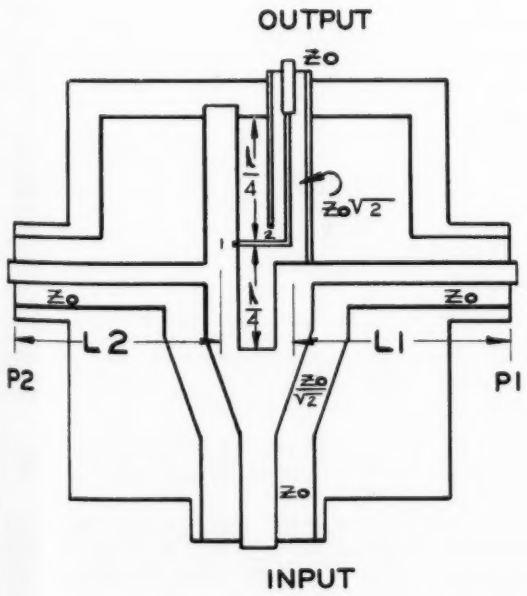

FIG. 1. COAXIAL HYBRID (Typical).

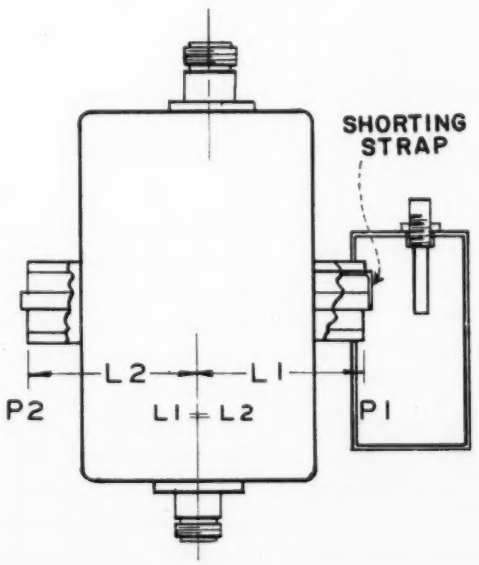

FIG. 2. SINGLE Channel Tunable Band RF Filter.

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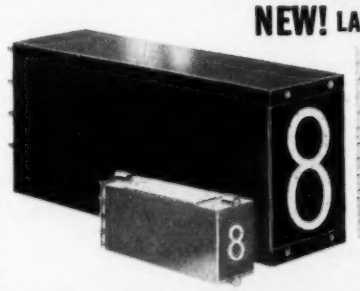

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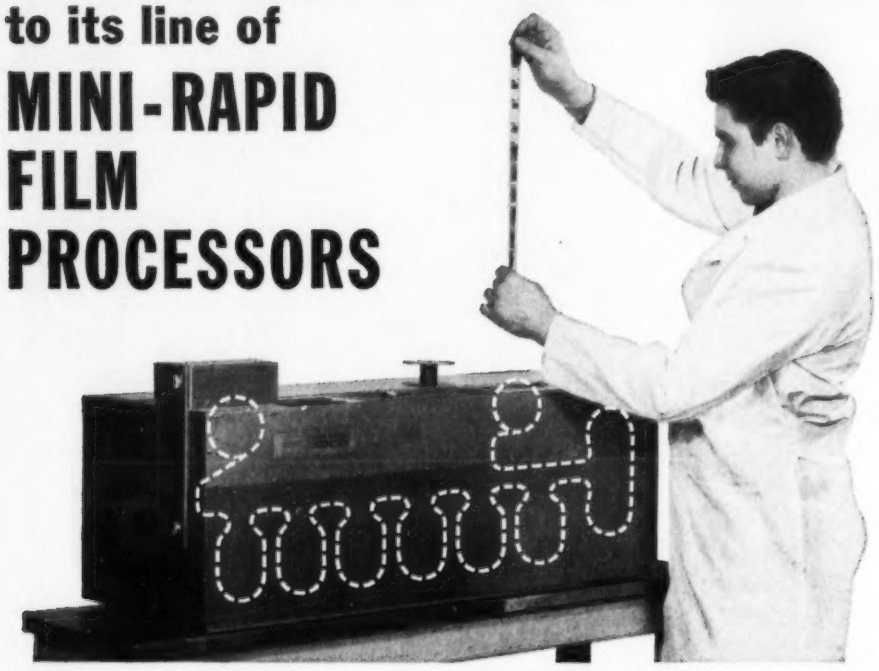

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Corona-Type Voltage Regulator Design

HIGH VOLTAGE—low current regulation, increasingly required in photo-multiplier tube circuits, closed-circuit TV, nuclear radiation measurement and new radar display and Xerography devices; has aroused interest in a type of gaseous diode known as a corona-discharge tube (Fig. 1).

The corona-type regulator has characteristics differing markedly from those of the more common "glow-discharge" type, widely used for low-voltage, high current applications. While the two modes of operation are somewhat similar, their obvious points of difference are important to the design engineer.

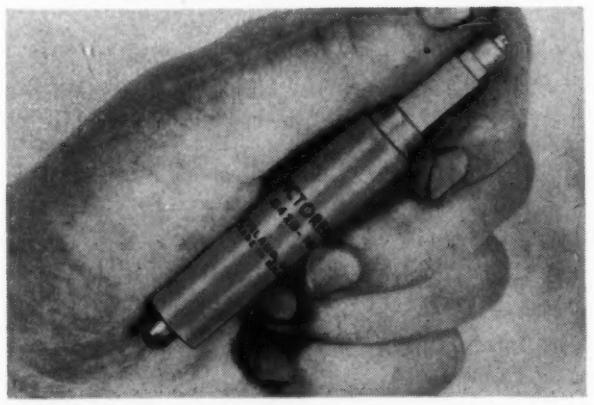

FIG. 1. CORONA TYPE Voltage Regulator is specifically adapted for high- voltage, low current applications.

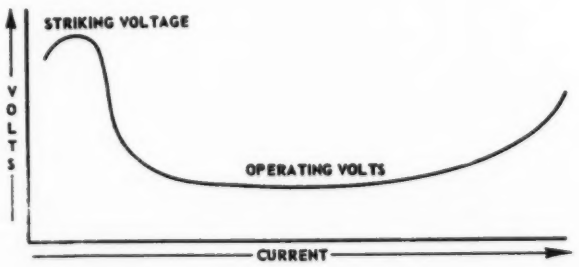

FIG. 2. GLOW TUBE regulation characteristic.

Glow tube operation, commonly used for voltages from 50 to 150 v and at currents from 500 μa to 50 ma, depends on a regulation curve (Fig. 2) which is usually negative in the normal glow region, changing to positive in the abnormal glow region. In contrast, the corona type tubes commonly operate from 330 v to above 25,000 v, and at currents from 5 μa to one or two milliamperes, with a regulation curve (Fig. 3) that is positive throughout its useful range.

Glow-tube operation is generally restricted to certain "natural" voltages determined by electrode material

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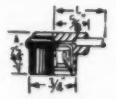
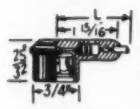
This is a new series of Tube Cap Connectors using special silicone components for high reliability applications. They provide the highest degree of resistance to temperature extremes and are virtually unaffected by ozone and corona. The excellent dielectric characteristics make them ideal for high voltage. Skirts and sealed-in leads guard against flashover at high altitudes. Additional features include anti-corona cup and long-life spring contacts.

Clip this out — keep handy for part numbers and specs on connectors below for either ¼" or ⅜" top caps. Prefix 90 for ¼"; 91 for ⅜". Lead wire 18" long from center of cap or length to your specs.

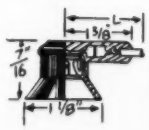


#90 or 91SCCSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout.

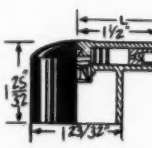


#90 or 91SCCRSL beryllium copper contact, cadmium plated nests in anti-corona cup. Silicone rubber insulation throughout. Takes up to one watt resistor — specify value and tolerance.

#90 or 91SCCDSL beryllium copper contact, cadmium plated nests in anti-corona cup. Skirt clings to tube — guards against flash-over. Silicone rubber insulation throughout.



#90 or 91SCCDRSL beryllium copper contact, cadmium plated enclosed in anti-corona cup. Skirt clings to tube — helps suppress corona—guards against arc-over. Takes up to one watt resistor. Specify value and tolerance.



#90 or 91CCSTLRL beryllium copper contact, cadmium plated nests in anti-corona cup. Glass-filled silicone insulation on cap; silicone rubber on lead. Long skirt for arc-over. Takes up to 2 watt resistor. Specify value and tolerance.

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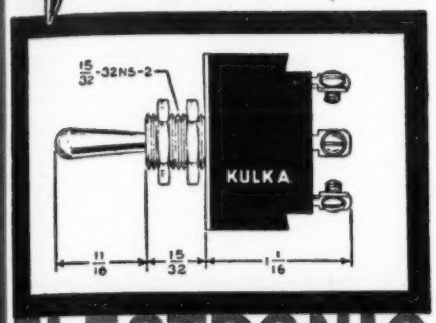

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and choice of gas, while corona voltage may be determined over a wide range by simply adjusting the gas-pressure. The glow tube with its negative resistance and wide spread between "ionizing" and "operating" voltage, makes a good relaxation oscillator and sawtooth generator, when used with shunt capacity. This is not true of the corona tube, with its positive resistance and no appreciable spread between "firing" and "regulating" voltages. Therefore, while a designer is cautioned against the use of condensers across the output of a power supply regulated by a glow tube, he is reasonably free to use them across a corona tube *if its operation is not extended into the glow region* even by momentary transients.

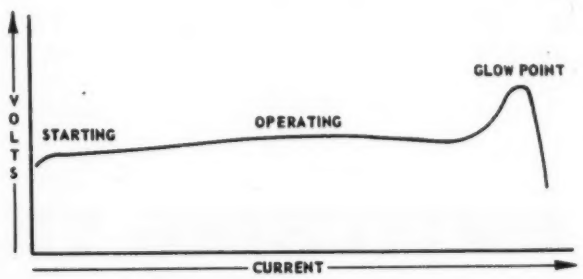

FIG. 3. **CORONA TUBE** regulation curve.

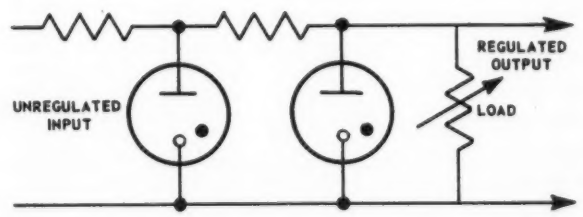

FIG. 4. **CASCADE** connection of corona type regulator tubes stabilize against input fluctuations and varying loads.

Fig. 4 shows a cascade circuit for stabilizing voltage against fluctuating input voltage and varying output current. The first regulator tends to overcome the effects of variations in input voltage, while the second imposes a constant load on the previously stabilized voltage. The reference voltage thus established compares favorably with that from much more complicated vacuum tube type regulators.

Corona type regulators have no filaments to burn out. The only possible failure is a gas failure which will operate to reduce the operating voltage, affording protection to the connected circuit. Also, the effect of ambient light on the operating characteristics has been overcome in the Victoreen Corona VR tube by introducing a small amount of radioactivity in each tube (Victoreen Patent).

(*From 8-page engineering brochure, "Corona Type Voltage Regulators", by Donald O. Ward, The Victoreen Instruments Co.,* 5806 *Hough Ave., Cleveland* 3, *Ohio*).

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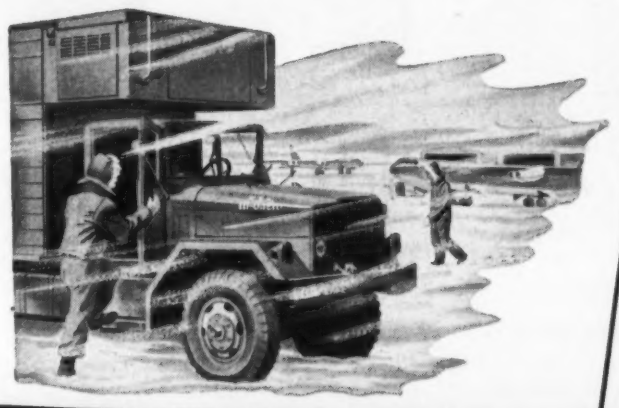
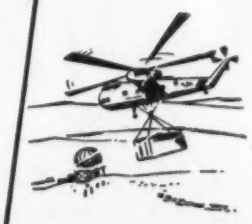
HEAT in military applications





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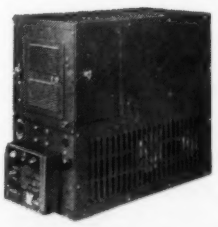

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MODEL UH-73-2: 50,000 BTU/Hr. • used in U.S. Signal Corps AN/MSG-4.

MODEL UH-58-SC-1A: 60,000 BTU/Hr. • used in S-44, CPN/18A, MPS/7, M-109, etc.

MODEL UH-47-4S: 15,000 BTU/Hr. • for use in small and medium size shelters.

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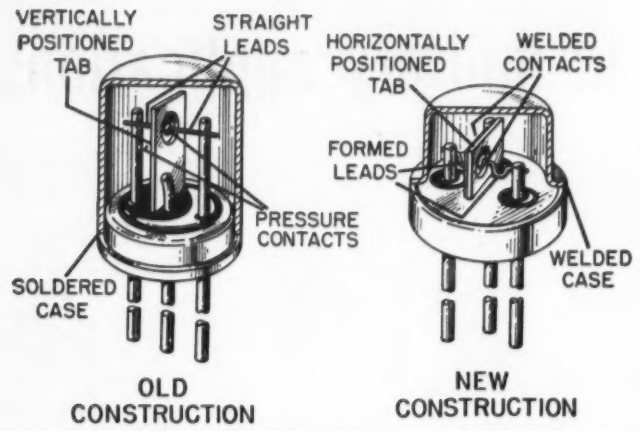
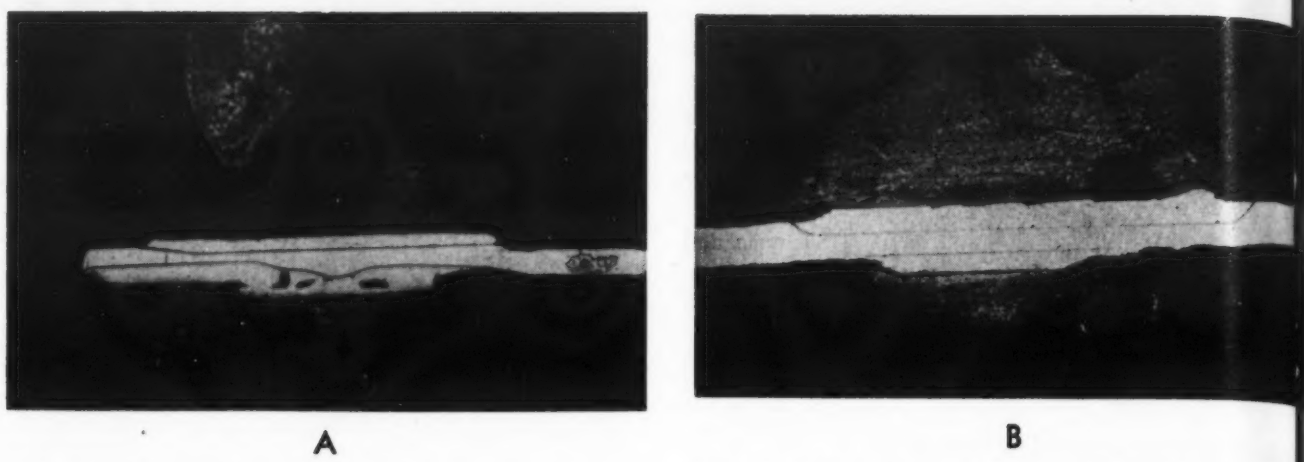


FIG. 1. MANY IMPROVEMENTS in transistor construction due to Planned Product Improvement Program are evident from a visual comparison of initial (left) with later (right)types.



A B

FIG. 2. PRECISE CONTROL of alloying process to produce even junctions (B), results in more uniform characteristics and elimination of "hot spots" for longer life and greater reliability.

RELIABILITY OF NPN SWITCHING TRANSISTORS

Reliability of transistors, like that of other components, is being improved through a deliberate process called the planned product improvement program. Progress in improvement of the NPN switching transistor at CBS-HYTRON, Lowell, Mass., one of the leading producers of transistors, is outlined by the manager for Quality Control.

GEORGE R. TALLENT
CBS-Hytron Division

NPN TRANSISTORS, preferred over the PNP type for computer circuits because of higher switching speeds resulting from the higher mobility of electron flow, have been produced by CBS-HYTRON since 1955. At present both 100 and 150 milliwatt transistors are being made in three major classes characterized by cutoff frequencies ($f_{\alpha_{co}}$) of 2.5, 5.0, and 10.0 megacycles, respectively. Some results of the improvement program are obvious from an inspection of the 1956 and 1958 models (Fig. 1). Others become evident only after exhaustive tests.

Reliability Improvement Program

Three basic factors were determined as contributing to unreliability of early transistors: (1) lack of control over formation of the alloyed junction; (2) contamination of the surface junction; and (3) poor mechanical strength of the assembled transistor.

The next step was the development of necessary production techniques and controls to eliminate those factors causing unreliability. This development followed a "feedback cycle" of evaluate-improve-evaluate illustrated in the following examples.

Alloying. Effect of precise control over time and temperature of the alloying process, developed by many studies over a long period, is shown by the junctions in Fig. 2. The uneven junction of the first transistors (Fig. 2A) affects the cutoff frequency $f_{\alpha_{co}}$ and the gain h_{fe} as well as causing localized heating during operation which shortens transistor life. In contrast, Fig. 2B shows flat even junctions which add greatly to the inherent reliability of the present day transistor.

Surface Contamination. Foreign ions deposited on transistor elements from moisture, residual etching solution and flux vapors from soldering were found to produce contamination. Entrapped moisture was eliminated when final stages of assembly and checking were accomplished in a dry atmosphere with a dewpoint below —40°C. Residual etch solution is now removed by multiple baths of hot, high-purity water, and welding of the can has eliminated solder flux and resulting flux vapors while simultaneously producing a truly hermetically sealed can. The improvement in collector cutoff current I_{co}, one of the parameters most affected by contamination, is shown in Fig. 3.

Mechanical Strength. Changes in transistor construction which have improved its mechanical strength (Fig. 1) are: (1) Emitter and collector leads are now electronically welded while older product was connected by pressure contact only; (2) Formed lead wires give added ability to withstand shock and vibration. Also, (3) horizontal position of the present

TABLE 1
FAILURE RATES IN PERCENT

	Old	New
High temp storage	8.0%/500 hrs	0.90%/1000 hrs
Low temp storage	N. A.	0.85%/500 hrs
Operating life	10.0%/500 hrs	1.20%/1000 hrs
Hermetic seal tests	11.0%	0.50%
Shock, vibration acceleration	N. A.	2.0

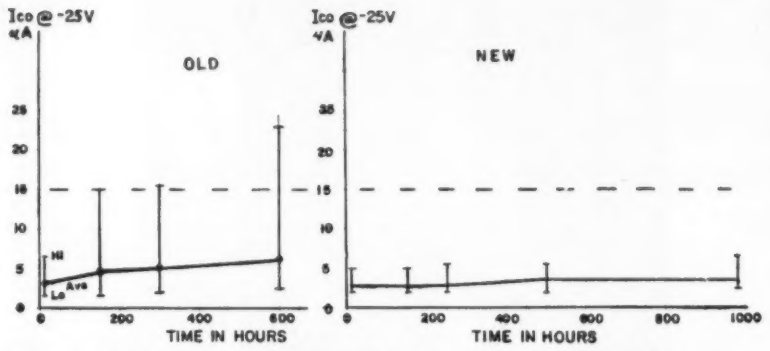


FIG. 3. RATE OF CHANGE of I_{co} Parameter during life tests.

tab has greater strength and is less subject to vibration than the vertical tab formerly used.

The foregoing are only a few results of the improvement program, which still continues. As fast as transistors can be improved, the reliability needed by transistor users increases still faster, the reliability demanded now being about ten times the level being achieved by manufacturers. In consequence, the user is required to use the devices at highly derated conditions.

Life and Environmental Testing

Reliability is defined as "the probability of a device operating within specified limits for the time and operating conditions specified." Although the purpose of life and environmental testing is to predict the reliability of a device in an actual use, it is the practice to perform tests at the maximum rated conditions of the device, on the assumption that the reliability under actual conditions will be greater. How much greater is the question now being studied by many semiconductor manufacturers.

Tests used at CBS-HYTRON in evaluating experimental improvements and reasons for each test are:

1. High temperature storage, non-operating, for 500 and 1000 hours. This most often results in a high leakage current (I_{co}) failure due to accelerated effects of surface contamination and degradation in gain (h_{fe}).

2. Operating life at maximum rated dissipation for 500 and 1000 hours. Failure modes are probably the same as for high temperature, with the addition of localized heating at junction "hot spots."

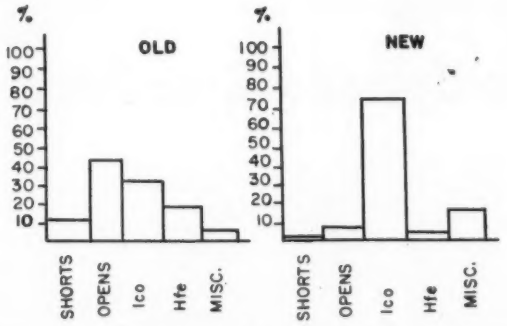
3. Low temperature storage, non-operating, for 500 and 1000 hours. Condensation of entrapped moisture which in time contaminates the junction is thought to be the cause of failure, resulting in excessive leakage with observable hysteresis.

4. Moisture resistance and other hermetic seal tests (10-cycle humidity per MIL-Std-202A, "joy-bomb" and helium leak detection) are used. Gradual leakage through the seal is believed a major cause of short life.

Mechanical shock, vibration and acceleration tests per MIL-T-19500A as guide.

An additional test now being evaluated combines high temperature with operating conditions.

TABLE 2. CLASSIFICATION OF FAILURES BY TYPES.



Catastrophic failures (shorts and opens) are greatly minimized by fabrication techniques discovered in CBS-Hytron Planned Product Improvement Program.

Test Data Evaluation

Parameters usually designated as life test points, to be measured initially and at end-of-life, are collector cutoff current I_{co}, emitter cutoff current I_{eo} and current gain h_{fe}. In addition, results at CBS-HYTRON indicate that collector breakdown voltage BV_{ceo} is also an important parameter.

Transistor failures, defined as the point at which a device ceases to perform its function within previously established limits, are classified as catastrophic or degradation failures. Catastrophic failures are usually opens, shorts and large increases in leakage currents. Degradation failures are test results exceeding previously set limits; e.g. for leakage currents the end-of-life limit is usually twice the initial limit, for gain the limit is usually 25-30% less than the initial limit. So far, no end-of-life limit has been set on breakdown voltage.

Stability of parameters, best shown by graphical analysis of test trends, is also an important consideration. The rate of change in I_{co} shown in Fig. 3 illustrates this point. Comparison of failure rates (Table 1) and in the types of failures (Table 2) affecting early and recent transistors reveal some of the fruits of the planned product improvement program at CBS-HYTRON, (Fig. 4) and show the high order of reliability which has already been achieved.

For more information on Transistors circle **74** on inquiry card.

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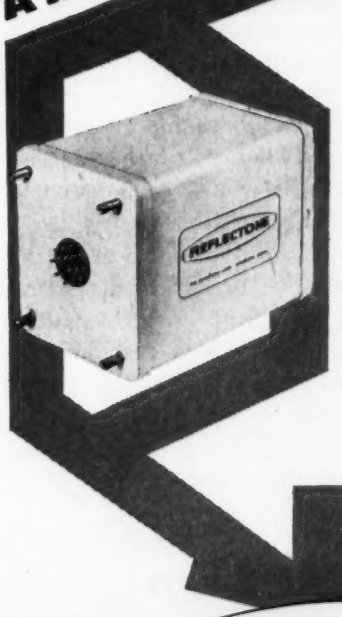

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Ball Bearing With Near-Zero Torque Upgrades Gyro Performance

GYRO MODERNIZATION through retrofitting with a radically new type of ball bearing to replace conventional gimbal bearings is now feasible. Important decreases in drift errors are reported to result from the reduction in bearing starting torque by a factor of 10 or more when new Dynamic Bearings, a development of The Barden Corporation, Danbury, Conn., are used.

The Dynamic Bearing is a self-contained, electromagnetically-powered ball bearing assembly that closely approaches the minimum friction achieved by knife edges, jeweled pivots or flotation devices, yet provides rugged support for relatively heavy gyro suspensions. Ease of incorporation into existing units is made possible by miniaturized designs which approximate the space requirements of conventional bearings (Fig. 1).

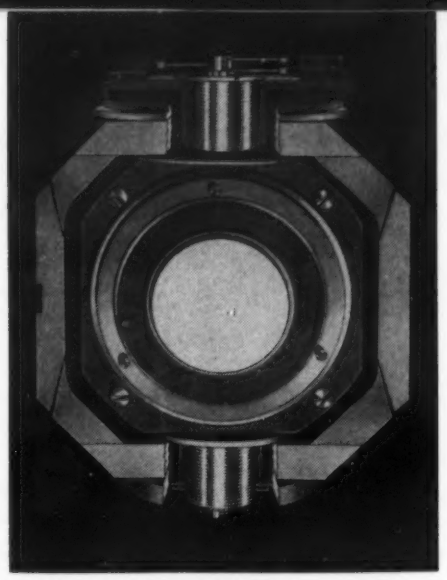


FIG. 1. DYNAMIC BEARINGS installed in gimbal bearings of a retrofit gyro.

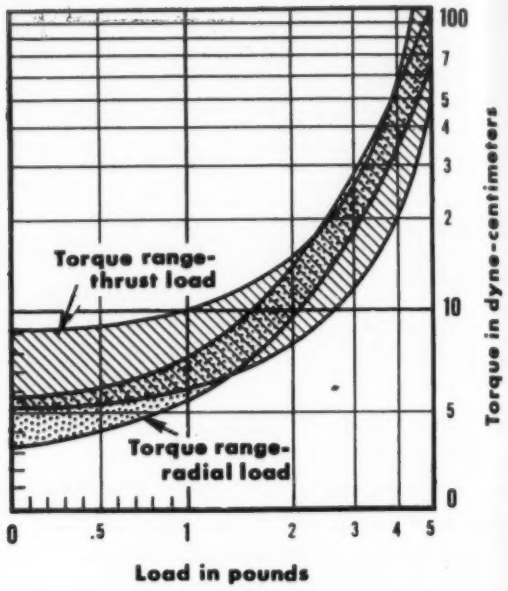


FIG. 3. TORQUE VALUES for Dynamic Bearings under radial and thrust loads.

The extremely low torque of the Dynamic Bearing is derived by mounting a bearing within a bearing (Fig. 2), the outer ring of the sensitive inner bearing being mechanically oscillated by an electromagnetic drive. This action tends to cancel the friction torque resisting the rotation of the supported member. The small residual torque is the restraint caused only by viscous effects, practically an irreducible minimum.

In tests at the Barden Laboratories, conventional low-torque ball bearings of 0.1875″bore under a 2-lb radial load show starting torques of 350 dyne-centimeters and running torque of 200 dyne-cm. Under the same load, Dynamic Bearings having the same bore show starting torque equal to running torque—both well below 25 dyne-cm. Endurance tests showed no increase in torque after 1,000 hours of operation in an open area without special protection.

Another advantage of the Dynamic Bearing is that it may be lightly preloaded to minimize mass shifts with only a moderate penalty in torque increase. The low torque conventional bearing previously mentioned, under a thrust preload of two pounds has a starting torque approaching 1500 dyne-cm. Under the same conditions of load and preload, a dynamic bearing of the same bore has a starting torque of from 15 to 30 dyne-cm.

An external oscillator is required to power the low-torque bearing, but since only one watt of power is required, the oscillator can be transistorized and made compact and rugged. If necessary, the oscillator can be located at a distance from the bearing assembly, with two-wire connections extending to any reasonable distance.

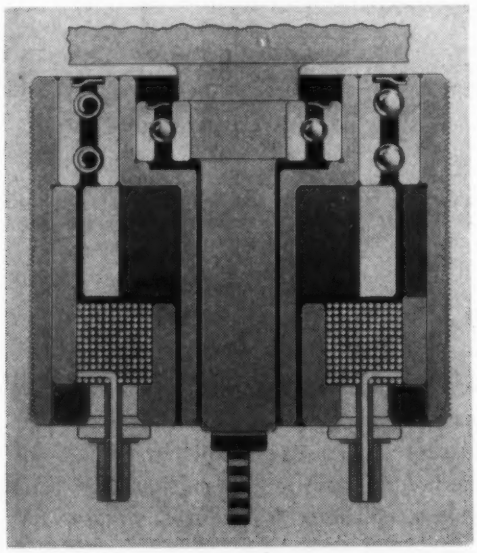


FIG. 2. CROSS SECTION of Dynamic Bearing showing inner and outer bearings and electromagnetic drive components.

Measurements to provide data for the accompanying torque-load curves (Fig. 3), which show torque ranges for typical Dynamic Bearings, required the development of new high-sensitivity torque-measuring techniques based on optical principles. Former methods based on physical contact between the measuring device and the bearing lacked the sensitivity needed to accurately detect the new bearing's resistance to rotation.

Aside from its low torque characteristics, the Dynamic Bearing has other design features that are attractive for upgrading existing gyros and other units on a retrofit basis. All components are mounted within a cylindrical outer housing, forming a "capsule" assembly for mechanical protection and for mounting in subassemblies. Also applicable in new gyro and other designs, the bearings can be designed to the specific needs of the application. Among feasible variations are those in size (Fig. 4), in style of mounting (flange, threaded or plain) and in detail design (cantilever or straddle).

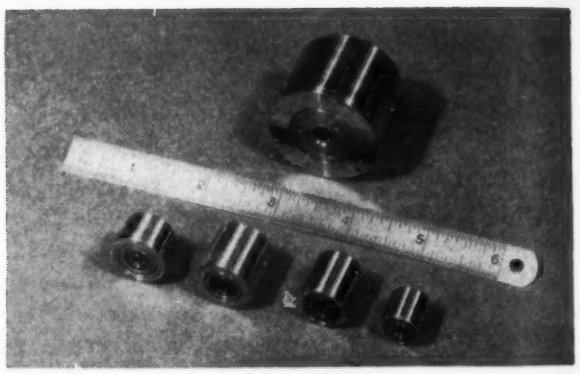


FIG. 4. FIRST PROTOTYPE Dynamic Bearing, with later miniaturized versions having flange, threaded and plain mountings.

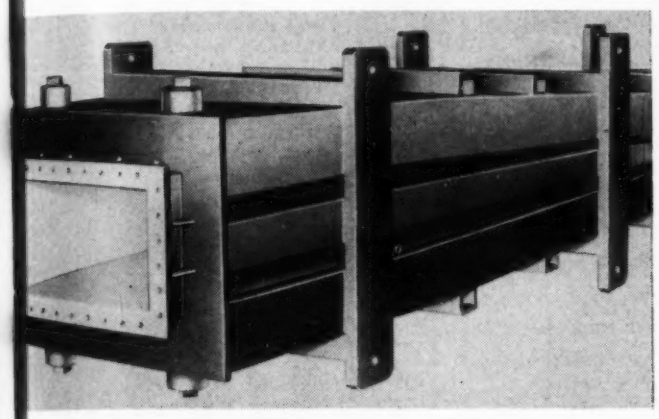
Although finding its first use in gyros and stabilized platforms, the principle of the Dynamic Bearing is also useful in new designs for scales, static balancing mechanisms or other precision devices where a rugged bearing must operate with extremely low torque. In gyro applications, its compactness and low-torque together with its dust-shielded construction, should open the way to a new level of sensitivity, accuracy and reliability in guidance and navigation systems, particularly for aircraft and missiles.

For more information on Dynamic Bearings circle **238** on inquiry card.

LARGE—WAVEGUIDE DUMMY LOADS

Safety precautions in military equipment bulletins have long emphasized the care that must be exercised by personnel working in or near direct beam of high-power microwave transmitters. The best method for minimizing this danger is to absorb the full output power of a transmitter undergoing tests and adjustments in which actual transmission is not accomplished by the use of a properly designed dummy load.

The recent trend toward high-power microwave applications in radar and scatter communications has



multiplied many-fold the former need for high-power dummy loads. At the same time, increasingly important missile-tracking and control operations are vulnerable to interference, making it necessary for many components of the Armed Forces to operate under strict radio frequency discipline when within large areas surrounding the testing ranges.

The Bogart Manufacturing Corporation, 315 Siegel St., Brooklyn 6, N. Y. has developed a full line of dummy loads to mate with standard wave guide flanges. The new WR4073 Series (Fig. 1), using dry VHP lossy material with auxiliary liquid cooling, is now available to mate with the WR2100 waveguide to absorb and dissipate average powers up to 60 kw and peak powers up to 15 megawatts. Other loads in this series mate with WR1800 (peak power 11 Mw) and WR1500 (peak power 7.5 Mw) waveguides.

Supplementing its high power and medium power dummy load series, the Bogart Mfg. Corp. also has announced a series of Bogart Mini-loads for low power applications. These tiny terminations also use VHP lossy material and come in forms for mounting in waveguides (4069 Series), or inserts already mounted in a short section of waveguide (4068 Series).

The WR4073 Series, Miniloads and Insert Series complement the nine waveguide loads comprising the 4063 Series, developed under Army Ordnance Corps sponsorship by the Bogart Mfg. Corp. This series has been assigned JAN nomenclature. Catalog sheets giving technical specifications of Bogart waveguide and coaxial dummy loads are available on request.

For this literature circle **75** on inquiry card.

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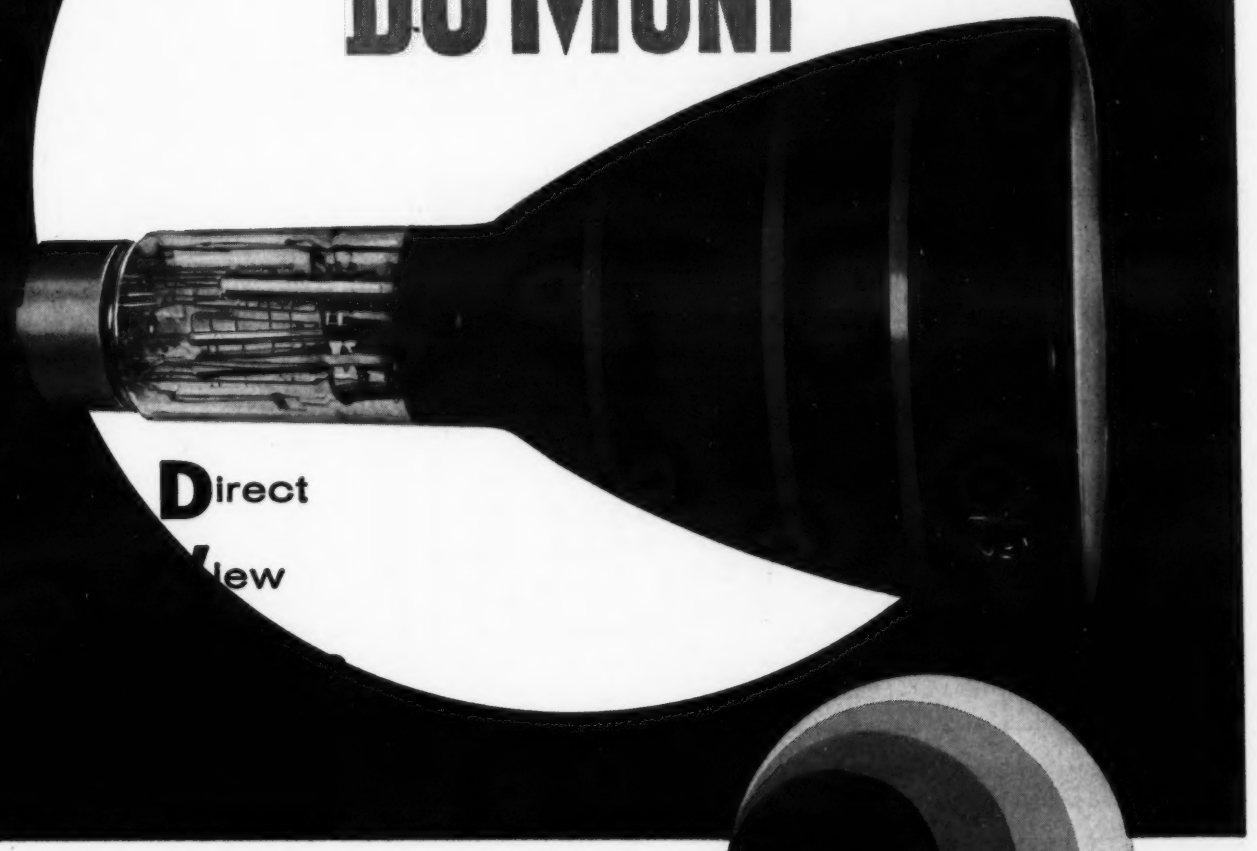

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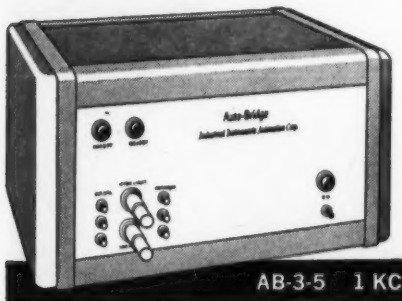

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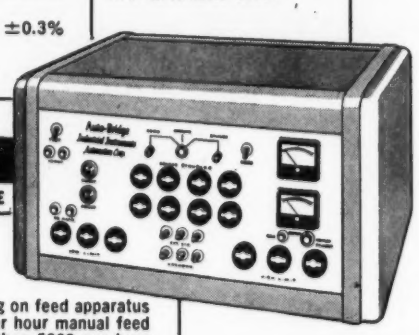

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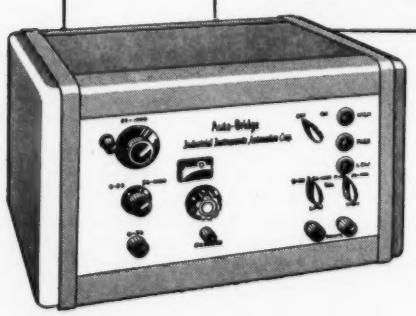
	100 ohms to 5 megohms.	±0.1%	
	5 megohms to 10 megohms	±0.2%	

AB-5-1 1 MC LIMIT BRIDGE*

	RANGE	ACCURACY	PROD. RATE
Capacity	0–1000 uuf in two ranges. (+ tolerance 0–100% – tolerance 0–25%)	±½% from 0–500 mmf ±1% to 1000 mmf	Depending on feed apparatus —1500 per hour manual feed to more than 5000 per hour with automatic feed.



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Diode Parametric Amplifier

MICROWAVE amplification, accomplished by a relatively new principle, first proposed in 1956 by A. Uhlir, then with the Bell Telephone Laboratories, has been applied in the Varactor amplifier, developed by F. S. Harris of Microwave Associates, Inc. The Harris technique of parametric, or negative reactance, amplification uses a resonant line circuit operating on the principal mode of propagation so that one cavity serves for both signal and idler resonant couplings. The amplifier provides physical separation of input and output couplings, and gives high performance without recourse to isolators, circulators, or hybrids.

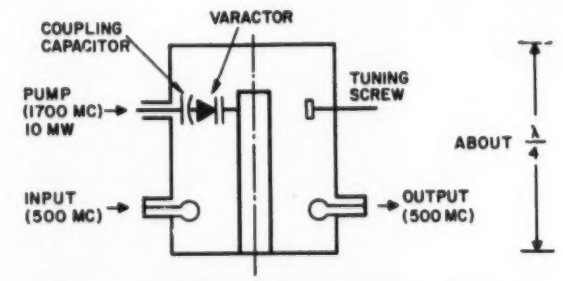

FIG. 1. HARRIS REACTANCE Microwave Amplifier, Schematic.

A varactor is a PN junction semiconductor diode designed for low loss at high frequencies. Its capacitance depends upon the voltage across the junction. This property and the fact that it has low loss permit its use in low-noise amplifiers, efficient harmonic generators, and high power control circuits.

Any PN junction diode has a non-linear charge voltage characteristic, which is all that is required to make a diode amplifier. However, to deserve the name "varactor"* and to be a serious competitor of vacuum tubes and point contact mixers, the diode must be designed to minimize high frequency loss.

To achieve low loss, the mesa-type diffused silicon design originated at Bell Telephone Laboratories under a Signal Corps contract is used in Microwave Associates varactors. The junction is produced on slices of silicon by solid-state diffusion of appropriate impurities. Then a small "mesa" is formed to reduce the capacitance to a value suitable for microwave use.

The P side of the junction has a large density of holes and the N side has a large density of electrons. A narrow region at the junction is practically free of holes and electrons and is known as the depletion region. The capacitance of the junction is, to good approximation, the same as that of a parallel plate capacitor made of material with the same dielectric con-

*The name "varactor" was suggested by M. E. Hines of Bell Telephone Labs.

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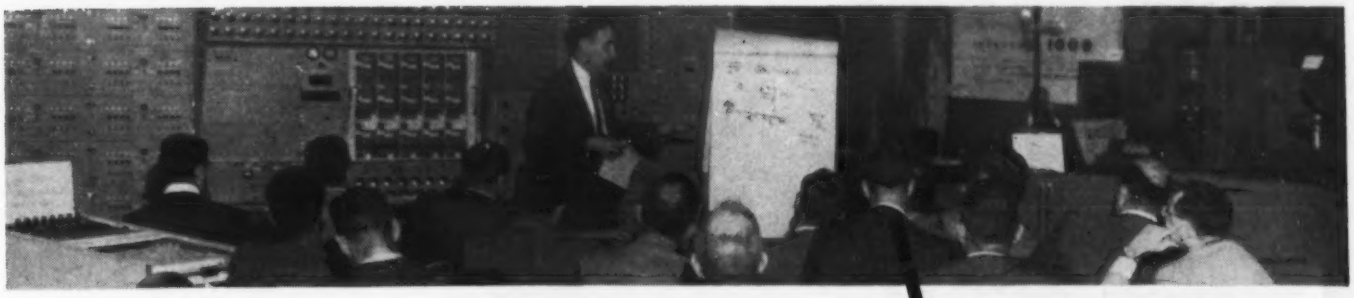
stant as silicon and of a thickness equal to that of the depletion layer. However, this thickness depends upon the voltage applied to the junction.

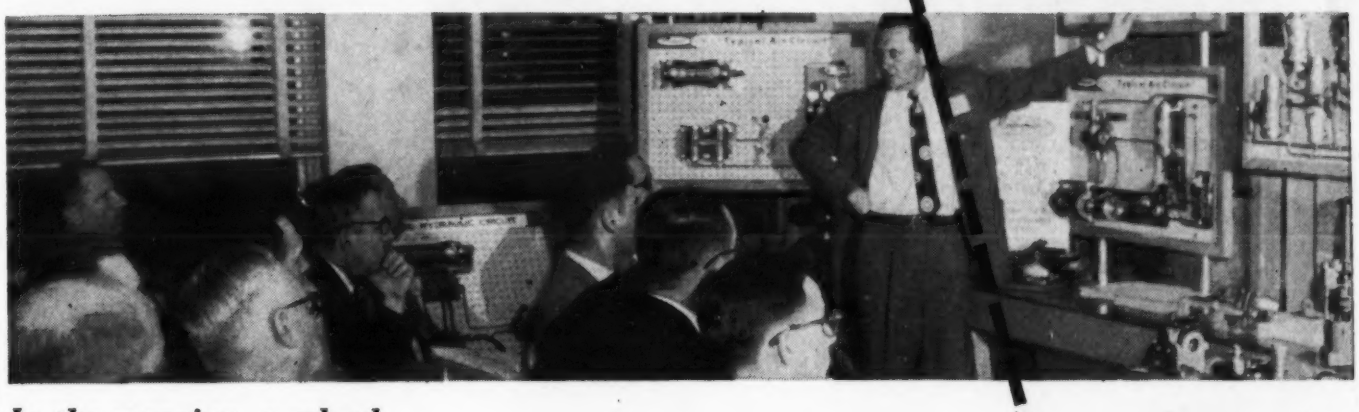
Microwave Associates' MA-1-450 amplifier uses one varactor diode mounted in a coaxial cavity. The amplifier cavity is generally connected to the receiver and the signal source as shown in Fig. 1. If the user provides his own pump, it should have the following features: Frequency range of 1000-2000 mcs with facility for setting to 1 part in 1000; and power output adjustable from 1 to 100 mw. Other desirable features would be: Output frequency independent of load resistance (within 1 in 1000); frequency and load setting controls independently variable; and output impedance such that negligible circuit damping is caused at signal or idler frequencies.

Outstanding features of this system, which have become apparent on application to practical systems, are: 1) *Extremely low noise factors*, of the order of between 0 and 1 db in the 500 mc region, have been obtained; 2) large dynamic range, typically 100 db, with still higher ranges possible, are accomplished without sacrifice of noise figure; 3) immediate recovery from temporary overload and resistance to damage from incident power levels results from automatic mismatch between varactor diodes which results at high power level. Also silicon diodes withstand far greater overloads than either point contact mixer crystals or close-spaced UHF triodes used in conventional microwave receivers. 4) Output signal is equal in frequency and phase to input frequency, regardless of the exact value of the pump frequency (from 2.5 times input frequency to 10 Kmc). 5) Cross-modulation interference from adjacent channel strong signals is greatly reduced due to the wide dynamic range of the diffused silicon varactor and the selectivity of the Harris Type of circuit. 6) Silicon varactors, unlike germanium diodes, can be advantageously pumped with a voltage that enters the positive voltage bias region, obtaining large dynamic capacitance variations in comparison to static capacitance. This makes the negative reactance amplifier a practical, stable device which considerably outperforms experiments previously described in technical literature.

This amplifier has been tested in amateur radio reception at 50 mc, 144 mc. and 432 mc. It also has been given more quantitative performance tests in the 400 to 500 mc region on satellite tracking radars, on tropospheric scatter systems and on an IGY auroral study receiver. Signal-to-noise ratio improvements of 4 to 6 db in comparison with low-noise planar triode vacuum tubes were observed, substantiating the measured noise figure of approximately 1 db for the varactor amplifier. (*"Varactors", a 13-page illustrated technical brochure by Dr. Arthur Uhlir, Jr., Director, Microwave R & D, Microwave Associates, Inc., Burlington, Mass., containing more information on parametric amplifiers is available on request*).

For this literature circle **76** on inquiry card.





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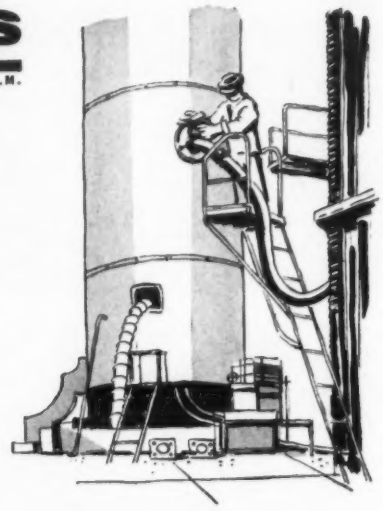
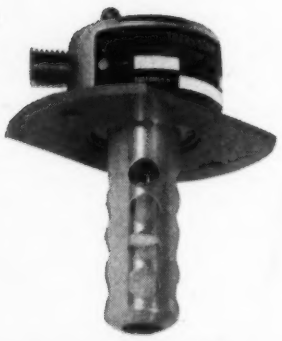
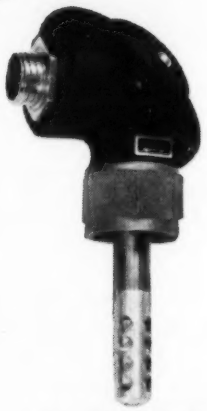


- No moving parts assure unsurpassed reliability
- Will not respond to wetting or splashing



IN-TANK SENSOR

ELECTRONIC UNIT
Explosion-proof version for ground installation



IN-LINE PROBE

Quartector Liquid Level Detection Systems, with no moving parts to stick or freeze, detect liquid levels to within ± 1/32″ with a response time of less than 40 milliseconds. Operating temperature range is from −425°F to +120°F.

Quartector systems and instruments are designed for *bulk liquid applications* such as fuel tanks in missiles or other types of pressure vessels, and for *pumping applications*. A real-time indication is provided when the liquid has reached pre-selected points in pipe lines or tanks.

The Quartector sensing element is a piezo-electric quartz crystal mounted in a probe or submersible sensor unit. Circuitry consists of a four stage transistor amplifier with a transistor detector circuit in the feedback loop, and an output control relay. When the crystal is in gas, it is free to vibrate at its natural frequency, and oscillation is sustained. When the crystal is submersed in liquid, however, its motion is damped, signal output drops, and the output control relay is de-energized.

Splashing, bubbles, and wetting do not affect the sensor. Liquid indication is given only when the crystal is completely surrounded by liquid. Safety features include a fail-safe and function test procedure. Write to Trans-Sonics, Inc., Dept. 12, Burlington, Massachusetts, for Technical Bulletin 1900.

TRANS-SONICS

Precision Transducers

*TRADEMARK

For more information circle **19** on inquiry card.

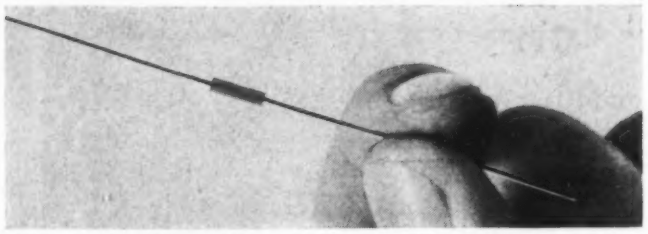


FIG. 1. ACTUAL SIZE of 1000 $\mu\mu$f Cerafil Capacitor, said to be smallest type of ceramic capacitors made.

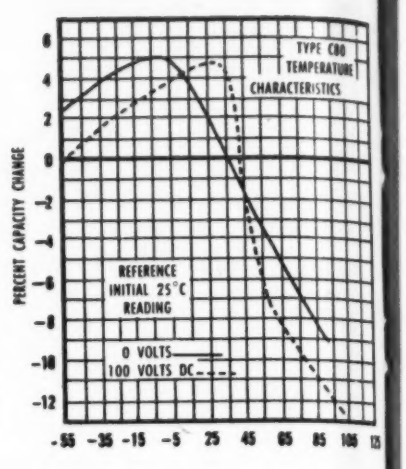


FIG. 2. TEMPERATURE CHARACTERISTIC of one general purpose capacitor. Characteristics vary with type of ceramic employed.

Micro-Size, Missile-Rugged Ceramic Capacitor

ELECTRONIC COMPONENTS for missile and space systems demand greater reliability with ever increasing miniaturization, ruggedness and ability to withstand extreme environmental conditions. Completely new concepts, radical designs and unique processes are made necessary because new system requirements can no longer be met by conventional components. Other electronic components must keep the pace set by the transistor in order to make full use of the transistor's volumetric advantages.

With these present demands and future super-critical requirements in mind, the Hi-Q Division of Aerovox Corporation under the leadership of Dr. Antonio Rodriquez, its director of Research, has evolved an all-new concept in ceramic capacitor fabrication, known as CERAFIL*, which meets the most exacting requirements for miniaturization and performance.

Ceramic dielectrics, because of their high dielectric constant and versatile electrical properties, have much to offer towards miniaturization. To make full use of the potentialities of ceramic dielectrics for miniaturization, however, they should be capable of being formed into a desired shape and dimension.

Unfortunately, the brittle nature of ceramics imposes certain limitations on the processing of thin ceramic dielectrics by conventional methods. Ceramic disc capacitors of 5 mils thickness are being produced but thicknesses of less than 5 mils become difficult to handle in a practical and economical manner by conventional methods.

* Copyright by Aerovox Corp.

Cerafil Technique

The Hi-Q Division of Aerovox has circumvented the obstacle of fragility of very thin ceramic sections by employing the Cerafil design and technique (Fig. 1). Cerafil is the Aerovox trade name for ceramic film. The main principle consists of forming the thin film of dielectric on a substrate, which is one of the electrodes and serves as a support for the fragile film. With this support, extremely thin films can be processed conveniently and resulting high capacities obtained. The voltage rating is determined by the thickness of the film, and the temperature characteristic by the type of ceramic employed (Fig. 2).

The Cerafil construction consists of a single capacitor element or a multiple of this capacitor element depending on the capacity value required. A capacitor element is a rod of approximately 1/32″ in diameter and a length determined by the length of the unit desired. The bundled rods form a cylindrically shaped honeycomb structure, the surface to volume ratio of which increases with diminishing rod diameter. The rod diameter selected is the smallest to be within practical methods or processing. Other forms and shapes such as plates and tubes may also be used as substrates.

In this construction elements of different characteristics may also be combined to obtain a resultant characteristic. For example, an element of positive temperature coefficient may be paralleled with one of a negative temperature coefficient to give a flat characteristic.

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For more information circle **20** on inquiry card.

Current Production

About three years ago the Signal Corps awarded the Hi-Q Division of Aerovox a production and facilities contract to manufacture Cerafil capacitors for general purpose applications. These ultra-miniature capacitors are now in volume production, and are available in any quantity in capacities from 10 $\mu\mu$f to 100,000 $\mu\mu$f. These miniature units are ideal for transistorized circuits in airborne and spaceborne equipment where weight and space are critical and at a premium.

Cerafil capacitors meet or surpass all requirements of MIL-C-11015A, and at present are undergoing extended life tests at 200 volts DC and 85°C. These groups have survived, to date, over 3000 hours with no failure. Cerafil capacitors to operate at higher temperatures up to 150°C, and possibly higher, are planned.

New Cerafil Developments

By modifications of this technique the volumetric efficiency of the design can be still further increased. For example, by placing parallel dielectric coatings on the rod the volumetric efficiency may be increased almost proportionally to the number of dielectric coatings in parallel.

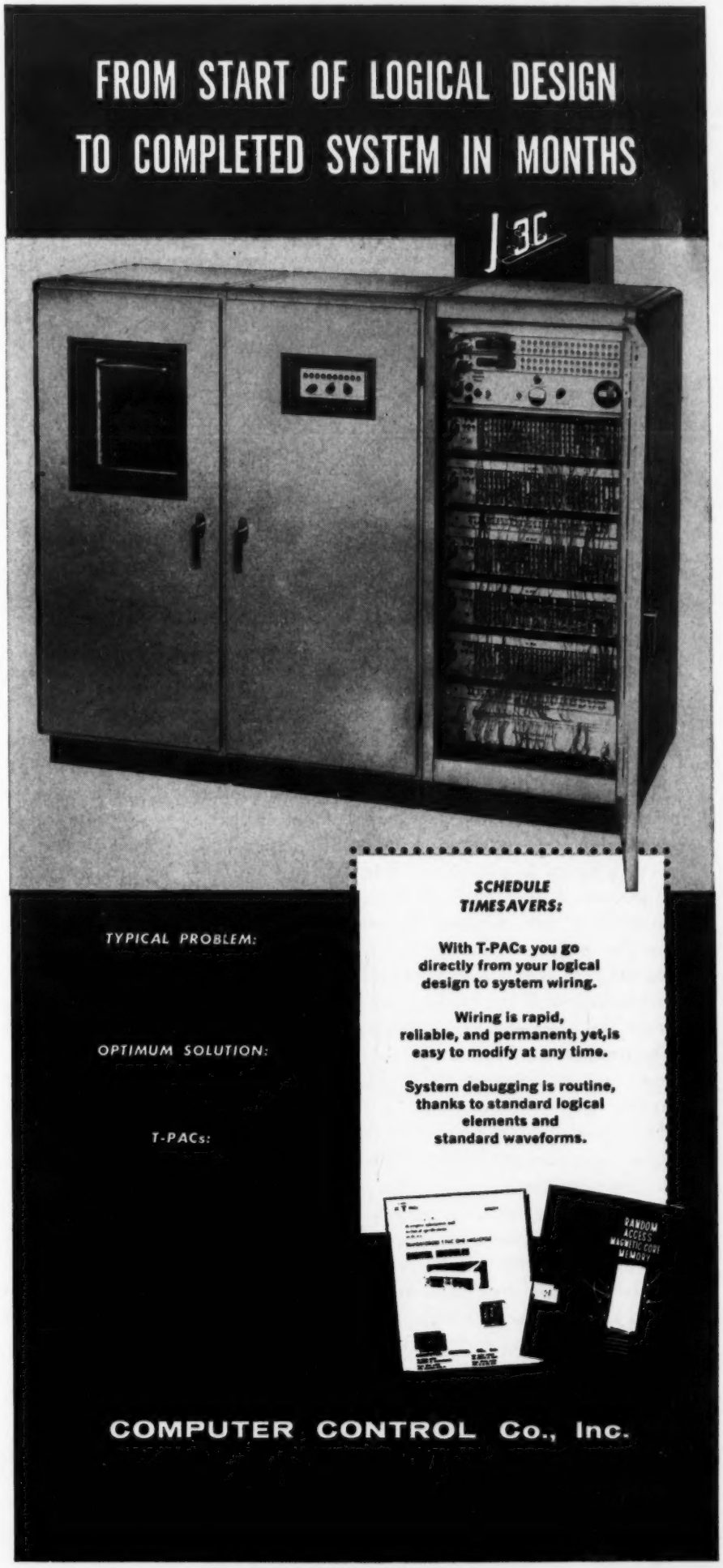
The Hi-Q Division of Aerovox also plans to apply the Cerafil technique to the development of precision temperature compensating capacitors for transistors, estimated to be in production within 20 months. Still other techniques of ceramic capacitor miniaturization now under development will be announced at a later date.

For more information circle **77** on Cerafil Capacitors

BOOK REVIEWS

1959 DIRECTORY OF MISSILE MANUFACTURERS, Federal Procurement Publications, Inc., 10-42 47th Rd., Long Lsland City 1, N. Y. 351 p. 8½" x 11", $25.00. Manufacturers of Missiles and missile components, are identified in terms of products; manufactured products, processes and services are identified in terms of firms. Cross-referenced geographically, with complete addresses.

PRINCIPLES AND APPLICATIONS OF ELECTRON DEVICES, by Paul D. Ankrum, Cornell Univ., International Textbook Co., Scranton 15, Pa., 667 p. 6" x 9", $12.00. Analysis of basic circuits using both tubes and transistors, intersperses physical background of circuit elements with specific circuit application.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For more information circle **21** on inquiry card.

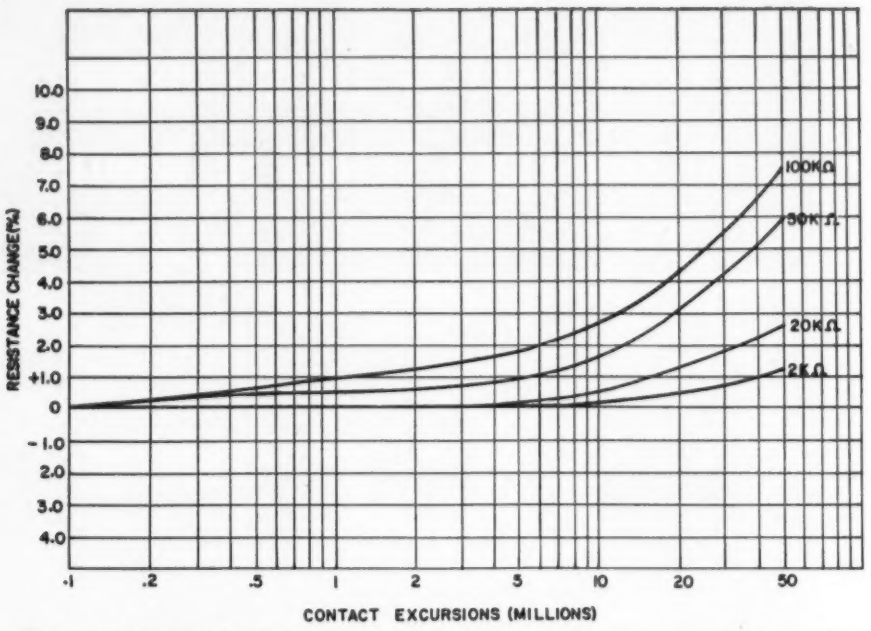


FIG. 1. ENDURANCE of Conductive Plastic Potentiometers is shown by exhaustive life tests.

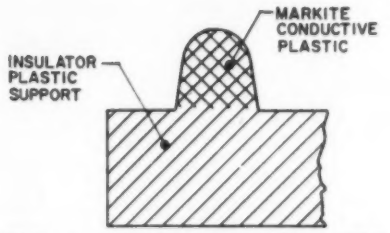


FIG. 2. CONDUCTIVE PLASTIC track is integrally molded with mineral-filled non-conductive plastic supporting base.

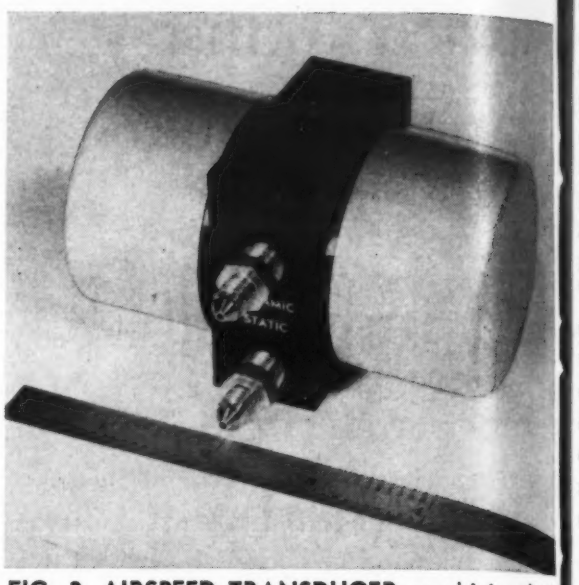


FIG. 3. AIRSPEED TRANSDUCER combining high reliability with miniature size, is typical Rahm Instrument application of plastic potentiometer.

Pressure Transducers Use Plastic Potentiometers

THE electro mechanical pressure transducer, in which a force collector—spring combination is used to position an electrical contact along a resistive element, has been restricted in the past by design limitations inherent in wire-wound resistor characteristics.

The concept of infinite resolution potentiometers in displacement type pressure transducers recently has been the object of considerable design and development activity. Rahm Instruments, Division of American Machine and Metals, Inc., Westbury, New York, has evolved a complete series of low, intermediate, and high pressure transducers (in the 0-1 to 0-7500 psi range) incorporating an infinite resolution type potentiometer.

The selection of the potentiometer required extensive investigation of deposited film types of resistor, both semiconductor and metallic varieties, and materials of a different nature herein described as conductive plastic elements. The investigation carried on at Rahm resulted in the selection of a conductive plastic material produced by the Markite Corporation, New York 14, N. Y. The criteria for this choice were the superior mechanical and electrical characteristics of conductive plastics, described below, compared to other types of infinite resolution elements. How these characteristics are contributing to the advancement of pressure transducer design will also be indicated.

Conductive Plastic Potentiometer Characteristics

Since the static and dynamic performance characteristics of any displacement type transducer utilizing a potentiometric output are intimately related to the physical and electrical properties of the resistor, the most significant features of the potentiometer structure are presented here for review.

The principal performance factors to consider in selecting a resistive element for pressure transducer design are wear, contact resistance variation, friction, temperature behavior, and resolution.

Wear: The enduring surface characteristics of the Markite conductive plastic can best be represented by the total resistance change as a function of brush excursions. Fig. 1 shows the average change in resistance for four ranges of potentiometers subjected to 50 million contact excursions. The life of the conductive plastic potentiometer far exceeds that of most pressure sensors under continuous cycling; the sensing element, not the potentiometer determining the life of the transducer.

Contact Resistance Variation: The contact resistance between the plastic element and wiper arm is not appreciably affected by a number of contact excursions (Fig. 1). The critical velocity of a wiper moving over the conductive plastic is much higher than that of a wiper moving across the winding of a wire-wound potentiometer, because conductive plastic has an extremely hard, smooth surface, free of irregularities. Although most users of potentiometric device desire the protection against open circuits, with a wire wound resistor there can be no guarantee against such failures. With a Markite resistor, the open circuit condition will not occur short of complete destruction of the element through excessive power dissipation or rupture of the mechanical system of the transducer.

Friction: The coefficient of friction at the point of contact of the wiper and the resistive element in any potentiometric design has been a major deterrent in realizing the full static performance capabilities of potentiometric transducers. The sensing element in a displacement type transducer is a force collector or prime mover. If the sensing element is required to overcome appreciable friction, not only are the characteristics of the spring loaded element no longer linear, but large frictional errors results. On the other hand, the extremely low coefficient of friction of conductive plastic potentiometers permits the designer to incorporate this type of resistor in high motion-amplification transducers.

A further advantage of the low coefficient of friction is that high contact forces can be used (20-30 grams) without significantly increasing the friction with the system or reducing the life of the unit, while for optimum performance of a wire wound potentiometer, contact forces are maintained between 3 and 4 grams. The higher contact forces made possible with conductive plastic elements are an asset when the unit is subjected to vibration, enabling test unit performance under higher G loadings without discontinuities between the contact arm and the conductive plastic element (Fig. 2).

Temperature: Temperature tests on conductive plastic potentiometers show that the elements exhibit a nega-

tive temperature coefficient (—0.0003 to —0.0004 ohm/ohm/Deg C from 0°C to 100°C). Although the elements can be shunted with a material of positive temperature coefficient to minimize this resistance change, this generally is not required in a potentiometric device. The change in linearity at elevated temperatures is extremely small.

Resolution: Resolution measurements have been made on the Markite element to four millionths of an inch. This was the limit of the available measuring equipment. This practically infinite resolution allows versatility in meeting specific pressure transducer requirements. The transducer can be designed for small deflection, thereby reducing the stresses in the sensing element and increasing the life of the transducer. High resolution of the Markite element also permits the design of pressure transducers of high sensitivity.

Pressure Transducer Designs and Ranges

Miniature Pressure Transducers: The Rahm Model 134 consists of a 7/8" diameter capsular pressure sensing element which actuates the wiper of a precision conductive plastic resistor. The output, in terms of resistance ratio, is linearly proportional to pressure input. Instruments in this group are available in ranges from 0-15 psi to 0-300 psi in absolute, differential, and gage pressure configurations. Designed for severe environmental conditions, without sacrifice of static performance, a high order of reliability was also achieved in this unit.

Higher Pressure Ranges: The Rahm Model 98, utilizing a Bourdon tube pressure sensing element, uses the Markite potentiometer to measure higher pressures up to 7500 psi in various media, including corrosive acids and reducing agents. As in the miniature unit, high performance and reliability have been combined.

Low and Intermediate Pressure Ranges: Model 155 transducers cover the range 0-1 to 0-150 psi for those environmental applications requiring the utmost in reliability and performance under high-G vibrations. All ranges in this group are available with infinite resolution potentiometers, including dual and/or functionalized output. This model can also be provided with an all stainless steel welded construction for corrosive media.

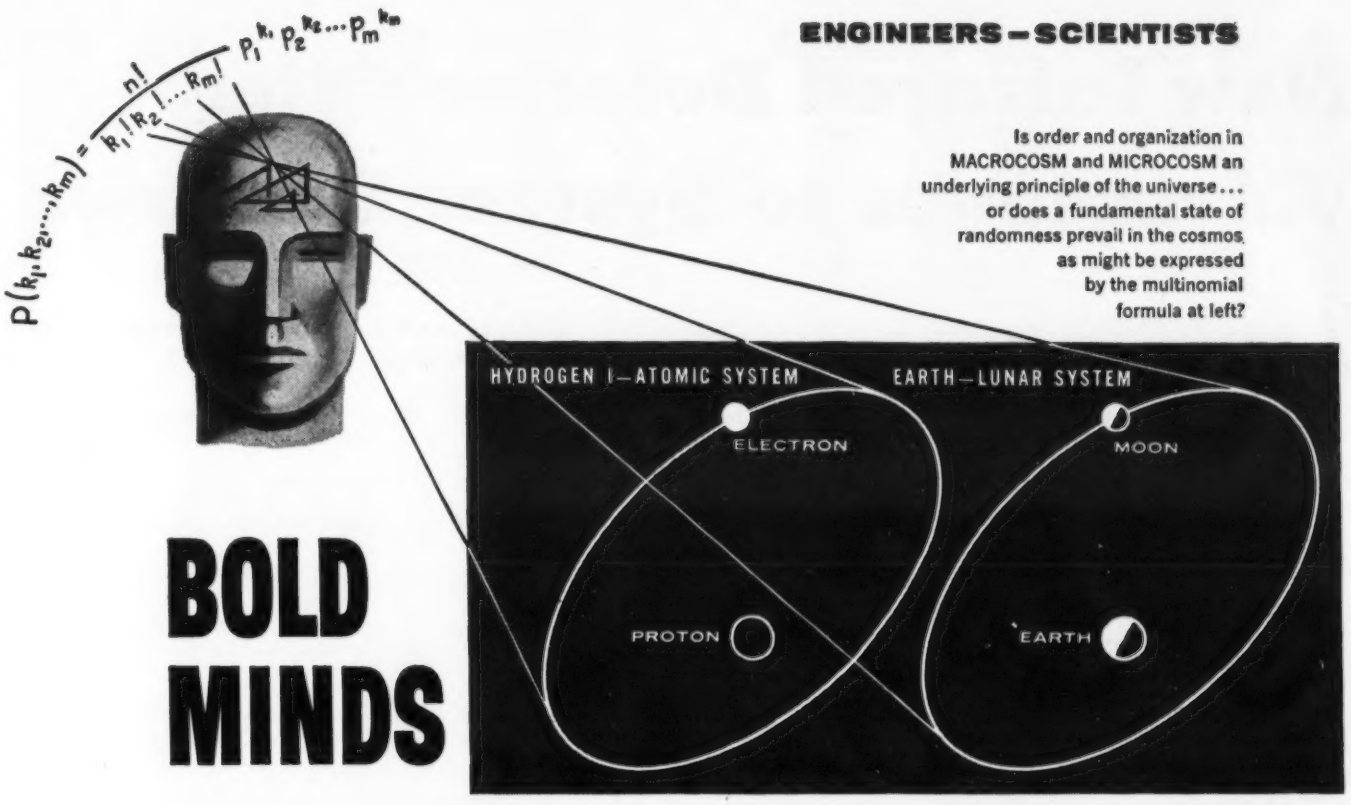
Special Transducers: Other Rahm instrumentation incorporates the conductive plastic element in a series of altitude and airspeed transducers (Fig. 3) and in certain special applications, functionalized output is possible.

Missile and space flight instrumentation require continuing refinements in durability and performance under the conditions of high vibration, shock, and temperature ambients. The replacement of the ultra-fine wire wound potentiometer with a product of superior wear and resolving properties is one step in the direction of greater reliability.

For more information on Rahm Transducers circle **78** on inquiry card.

For more information on Markite Plastic Potentiometer circle **79** on inquiry card.

ENGINEERS—SCIENTISTS



Is order and organization in MACROCOSM and MICROCOSM an underlying principle of the universe... or does a fundamental state of randomness prevail in the cosmos as might be expressed by the multinomial formula at left?

BOLD MINDS

THROUGHOUT HISTORY.....
BOLD MINDS have sought to understand the forces at work in the universe, and as they developed working hypotheses, endeavored to turn all knowledge to their own purposes, devising philosophical and mechanical systems of their own.

As old hypotheses become inadequate or untenable, thinking men devise new ones. So the concept of a "flat" world has changed to an oblate orbiting spheroid—mere speck in a vast and expanding universe; so "empty" formless space is regarded as a curved continuum occupied by random knots of turbulence (creating the new branch of mechanics—hydromagnetics).

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For more information circle **22** on inquiry card.

New Infrared Detector Offers Advantages to System Designer

AN INFRARED detector of new, miniature design, (Fig. 1), utilizing the photoconductive effect in indium antimonide,, has been developed by Radiation Electronics Corporation, 8241 North Kimball Ave. Skokie, Illinois. In conjunction with auxiliary components described below, this detector (Model PC-02) is currently being used as the basic element of infrared detection and measurement systems. Its high sensitivity, relative ease of cooling, low microphonic susceptibility and extremely fast response make it particularly advantageous for missile and other airborne applications.

The properties of the PC-02 detector are given in the Table, also the spectral response is shown in Fig. 2. The spectral response of the indium antimonide photoconductive detector is of special interest for discrimination against sky background clutter. By utilizing the spectral region between 3.5 and 5 microns, which corresponds to a prominent infrared "window", the effect of scattered sunlight and emitted thermal background radiation may be minimized. The detector time constant, wave length response and high sensitivity at the dry ice point (—78°C) are of particular interest for high speed airborne search systems and advanced air-to-air homing missiles. Other representative applications are discussed below.

The high sensitivity of the detector at the dry ice point is important since cooling may be achieved by means of relatively simple and reliable cryostats. A typical cooling unit, consisting of the cooling head (Fig. 1) and a small bottle of liquid CO_2, will provide cooling for normal operations for a period of about 18 hours per pound of liquid CO_2.

INDIUM ANTIMONIDE DETECTOR PROPERTIES MODEL PC-02

*Noise Equivalent Power (NEP)	— 1-2 x 10^{-10} watts, 500°K blackbody source, 1 cps bandwidth at 400 cps, 1 x 1 mm area
Cell Area	— 0.5 x 0.5 mm to 2 x 2 mm
Operating Temperature	— Dry ice point (—78°C)
Resistance	— 40-200 ohms
Time Constant	— Less than 1 microsecond
Window	— Sapphire

*Noise Equivalent Power is the average watts required to give a signal equivalent to the rms noise from the detector.

Since this detector is a low impedance device, it was necessary to develop special transformers and preamplifiers to fully utilize its sensitivity. A transistorized pre-amplifier and a vacuum tube pre-amplifier are now being manufactured for use with this and other low impedance devices. The frequency response of these amplifiers may be extended to two megacycles permitting adequate utilization of the detector's short time constant for high information-rate applications.

The photoconductive InSb detector is being used as the basic element of a high speed radiometer. This instrument is capable of detecting thermal transients of 10 microseconds duration, thereby providing temperature profiles of rapidly moving objects. Such rapid temperature variations may be detected over a room temperature (20°C) surface with a sensitivity of 0.1°C. It is expected that this radiometer will find use in wind tunnel and shock tube determinations of temperature profiles of missile and aircraft sections undergoing simulated high speed flight.

An important application of the detector is its use in high speed thermal scanning or imaging devices. Scanning equipment has been constructed which will scan a moderately large field of view at a rate of several frames per second. Relatively low susceptibility to microphonic noise permits full utilization of the detector's sensitivity in the presence of vibration and other mechanical motions. High speed InSb scanning devices are capable of sensing variations of 0.1°C over ambient temperature surfaces.

Scanning systems, using these detectors and auxiliary components, may be applied to airborne early warning, air-to-ground thermal mapping, and battlefield reconnaissance.

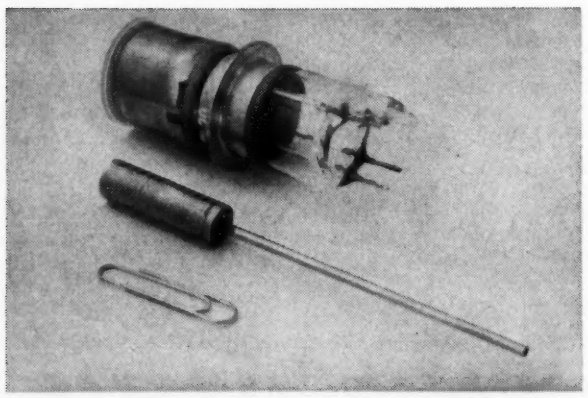


FIG. 1. INDIUM ANTIMONIDE is the photosensitive element in the new Model PC-02 infrared detector. Cooling head for liquid CO_2 is also shown.

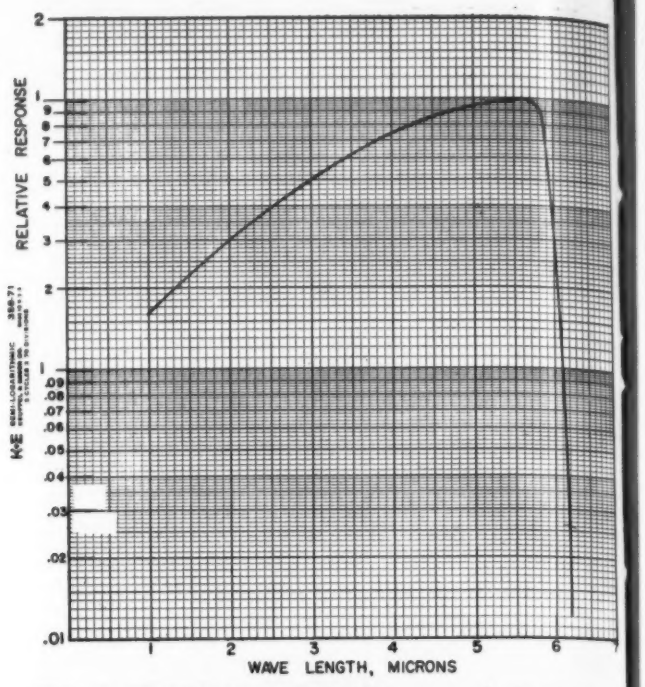


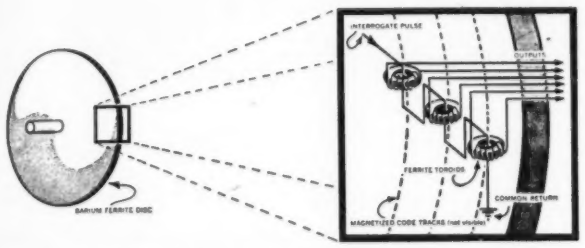
FIG. 2. SPECTRAL RESPONSE curve of photoconductive Indium Antimonide detector.

FIG. 5. SENSITIVE, HIGH SPEED IR devices are made possible by short time constant, low noise and high sensitivity of PC-02 detector. Thermograph of face and head shows temperature variations of 0.1°C. Contrast between black and white areas corresponds to 2°C.

For more information circle **80** on inquiry card.

Digital Encoder has Unique Magnetic Readout Technique

Magnetic Readout, a principle successfully used in computer memories, is being applied by ASCOP in their new Model EPD-3 Shaft Positon Digital Encoder which is said to offer broad advantages over conventional shaft-position readers. By using a magnetic readout, exceptionally rapid access is achieved without moving or rubbing parts other than the shaft. Since there is no dependence on physical or optical contact, there is no deterioration of reading ability because of wear or dirt, and unusually long, trouble-free life can be expected. This makes the Model EPD-3 particularly advantageous for applications where long unattended operation in poor environments will not alter its reliability.



SCHEMATIC DIAGRAM of magnetic readout technique in the Ascop EPD-3 shaft position digital encoder (patent pending).

A shaft-mounted barium ferrite disc is radially spot magnetized in discrete code spots arranged in concentric tracks around the wheel (See Figure) Above each track a small ferrite toroid is mounted. When the toroid is above a magnetized spot, the spot's magnetized field causes the toroid to saturate. When a constant current interrogate pulse is passed through the toroids a voltage pulse appears across those which are not in a magnetic field (saturated condition) at the time. Parallel outputs from the toroids then indicate in binary code the exact angular position within ½° of the ferrite disc, whether it is at rest or rotating as fast as 10,000 rpm.

Because of the type of readout, shaft positions can be read on demand at any desired rate up to 5 megacycles per second. Since the torque is low, (0.2 in-oz breakaway), practically no load is placed on the shaft to which it is attached. The low output impedance of the device assures that the encoder can be placed at a considerable distance from following computer or logical circuitry, which might include data logging equipment or shift-register/computer combinations.

Specifications of the EPD-3 include ½° resolution on 3″ disc; dimensions, 3¾″ dia x 1.391″ long, with 3/16″ shaft; output, 70 ohm parallel, on demand; max. speed, 10,000 rpm, with full count in 1 revolution for single disc model.

The Model EPD-3 is one of many possible analog-to-digital shaft position encoders using the new ASCOP readout technique.

(From 4-page technical brochure, Applied Science of Princeton, P. O. Box 44, Princeton, N. J.)

For this literature circle **81** on inquiry card.

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In Canada: CANADIAN MARCONI CO., LTD., TORONTO 17, ONT.

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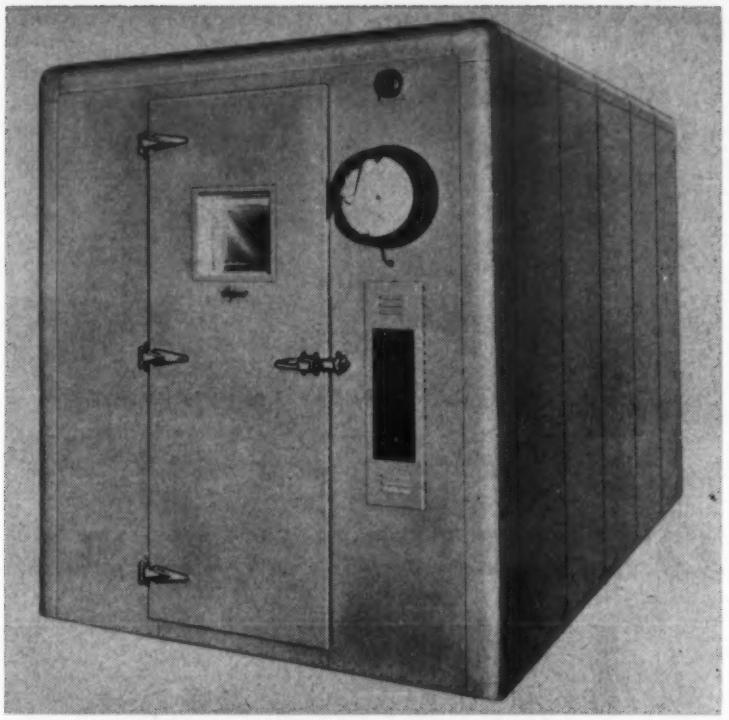


FIG. 1. PORTABLE ENVIRONMENTAL ROOM for testing or assembly under closely controlled atmospheres is also used as a computer housing facility.

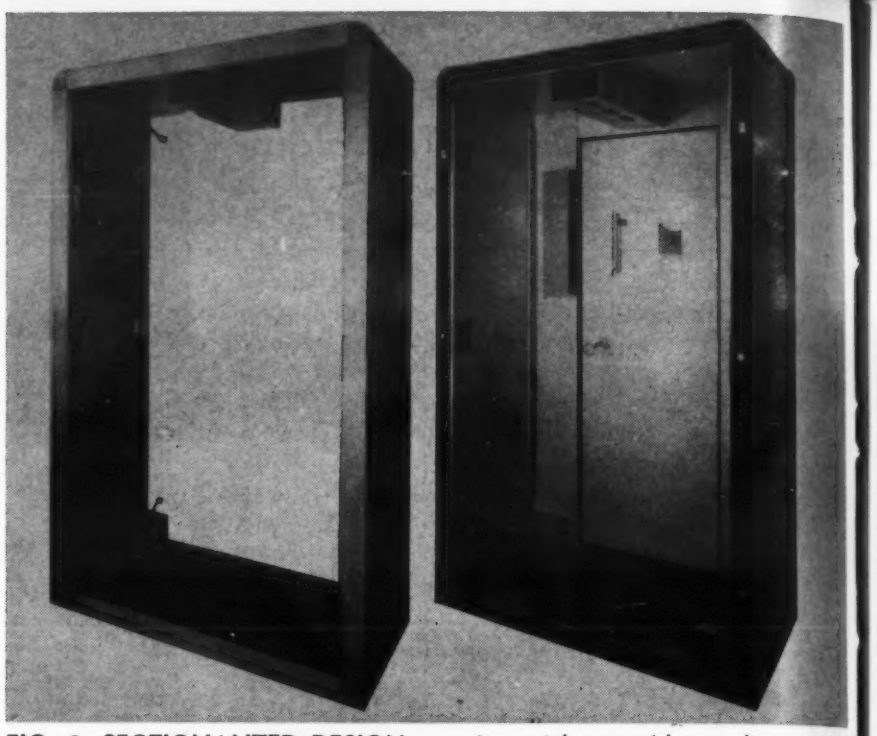


FIG. 2. SECTIONALIZED DESIGN permits quick assembly or disassembly, or adjustment of room size by addition of additional center sections (on left).

Portable Environments for Testing, Assembly or Computer Operations

HIGHLY CRITICAL testing, delicate assembly operations and computer facility specifications often demand closely controlled atmospheres. To provide improved results in such areas, a completely portable environmental room has been developed in which heat, cold, humidity or dehumidity are regulated within very close tolerances.

Portable environmental enclosures thus permit quick conversion of established manufacturing and engineering facilities to handle operations requiring a new order of environmental control without the disruption and cost of major new construction. The room (Fig. 1) is a development of the Hotpack Company, Inc., Philadelphia 35, Pa.

For specialized assembly procedures involving sealed relays, transistors, potentiometers and other sensitive electronic components, a constant temperature of 73°F (±1°F at control point) and a relative humidity of 35% is maintained within the room. Special air filtering and purifying equipment, capable of removing dust particles of less than one micron in size, are built in. Temperature ranges to 125°C allow the room to double as a test chamber for components requiring JAN, ASTM, MIL-STD-202-A heat and humidity tests. The work table is easily removed from the room to permit large scale placement of the components for the test period. Room is designed to accomodate racks for this purpose. Humidity of the room is adjustable from 20% to 98% R.H. When used as a computer housing facility, refrigeration and humidity control units act to compensate for temperature and humidity changes which retard computer system efficiency.

Conditioned air within the room is mechanically convected by a large capacity blower, to insure each part of the room the same quantity of heat and humidity. Although the air flow velocity is slight, air movement is sufficient to prevent "pocketing" of heated vapor and to provide constant temperature levels.

Positive air pressure within the room prevents infiltration of outside air which could disturb or contaminate the interior environment. An open coil heater design exposes all heater surfaces to the channeled air current to eliminate temperature "overshoot" during thermostat operation. Other temperature safeguards include an adjustable automatic over-temperature controller to prevent dangerous heat increases in event of thermostat failure or improper adjustment, and a built-in pilot light and alarm system provide instant indication of heater circuit failure.

Accurately controlled relative humidities are maintained without condensation or interference with temperature control by atomization of tempered water into vapor. Water is first passed through a filter which removes all foreign matter, and is then passed to the inlet regulator for processing into thin vapor.

Facility is Quickly Re-located

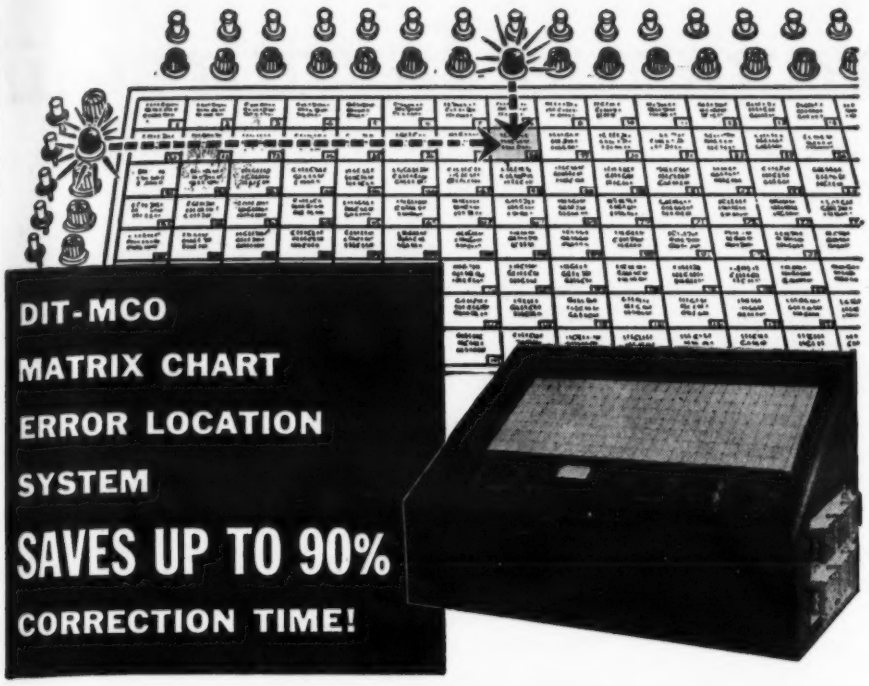
The sectionalized, prefabricated design of the room permits easy assembly or disassembly within a few hours. No specialized labor, blueprints or complicated assembly procedures are required for installation. Also rooms may be moved and relocated as requirements change without excessive labor costs or loss of material. Room size may be increased by simple insertion of additional center sections (Fig. 2).

Construction is heavy duty aluminum with all framework reinforced for greater strength and durability. Double floor construction provides space for computer cables, etc. In addition, rooms are adaptable for recessed mounting to form an integral part of the installation.

Extra precautions are included to eliminate dust and dirt. A single sheet vinyl floor covering is used to avoid cracks that might accumulate dust and hamper cleaning operations.

All power switches, through wall connections, and other interior electrical devices are recessed into the wall to reduce dust catching. All joints between the sections are tightly sealed. Windows are of the double glass type to protect against air loss and prevent dust infiltration.

For more information circle **82** on inquiry card.

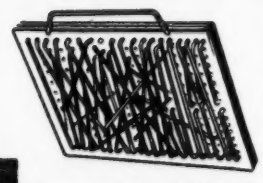


Pinpoints All Circuit Flaws Instantly...Plots and Simplifies Test Procedure...Provides a Permanent Record!

DIT-MCO's revolutionary Matrix Chart is the only error location device which puts all circuit information . . . errors, circuit numbers, type of flaws, etc. . . . directly in front of the operator of this Automatic Electrical Circuit Analyzer. It plots the entire test sequence and pinpoints every circuit flaw . . . instantly! Horizontal and vertical indicator lights cross reference to indicate the exact error location, circuit number and type of flaw. As errors are detected, they are recorded on the proper matrix square and the test continues.

Once the test sequence has been completed, all corrections are made direct from the Matrix Chart. This *group correction* feature saves up to 90% of error correction and/or interpretation time by eliminating time-consuming searches through complex manuals and wiring diagrams. After corrections have been noted on the Matrix Chart, it provides a complete record of test circuits, test specifications, instructions, results and modifications. This concise, understandable record improves interdepartmental communications and provides co-ordination through all stages of planning, production and maintenance. Non technical personnel easily master operation of the Analyzer and use of the Matrix Chart System. The final Matrix Chart can follow the product for future overhaul and maintenance use.

DIT-MCO, Inc. employs an experienced staff of sales engineers in the field. Contact your field sales engineer or write for important facts about DIT-MCO Automatic Electrical Circuit Analyzers.



PLUGBOARD PROGRAMMING SPEEDS TESTING!

Jumper-wired plugboard programming permits use of simple, straightforward adapter cables. Circuit modifications never present headaches because all changes are easily made by re-jumpering the readily accessible plugboards.

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For more information circle **24** on inquiry card.

Standard Microphones for Sound Pressure Measurements

New line of standard sound pressure microphones, having virtually infinite acoustic impedance and designed for making accurate sound pressure measurements over very wide frequency and dynamic ranges, are stiffness controlled over the specified frequency ranges and introduce negligible phase shift errors making them ideal for accurate reproduction of acoustic transients. These microphones are suitable for measurement of not only conventional sound pressure levels but also blast pressures and shockwaves such as are generated by gunfire or explosions.

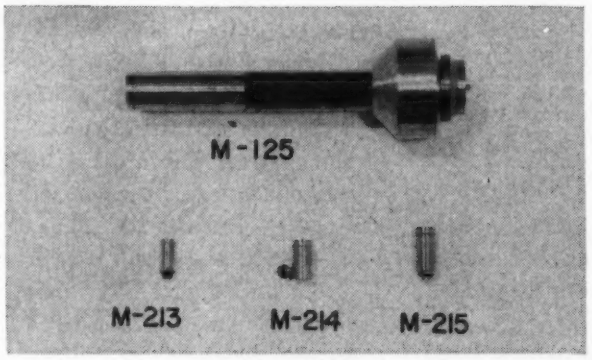


TABLE 1. SOUND PRESSURE MICROPHONE CHARACTERISTICS

Model No.	Frequency Range cps	Open Ckt. Sensitivity μv/μbar	Rise Time μ sec	Threshold* db vs 1 μbar 1 kc	10 kc
M-125	20-30,000	23.6	10	—66	—86
M-214 M-215	20-70,000	12.5	3.5	—52	—72
M-213	20-90,000	8.0	2.5	—46	—66

*Threshold is the equivalent sound pressure level per 1 cycle band-width to generate a signal equal to the thermal noise voltage of the microphone.

The fundamental piezoelectric constant of the ADP (Ammonium Dihydrogen Phosphate) crystal used as the active element is employed for the conversion of acoustic energy into electrical energy; the microphones behaving essentially as primary standards insofar as sensitivity and stability are concerned.

The smallest unit, M-213, is best suited for measuring transients with extremely fast rise time, for free field measurements with minimal diffraction errors or in making sound pressure measurements well into the ultrasonic range. Models M-214 and M-215 are somewhat larger, have increased sensitivity and lower threshold. These make ideal probes for introduction into conduits or chambers for measuring intensity and phase of wavefronts in traveling or standing wave systems. Model M-125, having highest sensitivity and lowest threshold, is particularly suitable for accurate calibrations of sound fields throughout the audible frequency spectrum. (*From Data Sheet* 21-17, *which also lists accessory equipment for sound pressure measurement. Kin Tel Div. Cohu Electronics, Box* 623, *San Diego* 12, *Calif.*)

For this literature circle **83** on inquiry card.

A Logical Deduction

Because the design of an NJE SOLID STATE transistorized power supply permits **no compromise with quality;**

Because every transformer and choke is a **MIL-T-27-A** style unit; every resistor is **wire-wound;** every capacitor is the **finest** of its type;

Because every component is significantly derated at the **worst combination** of line, load, and ambient conditions, including repeated short circuits and critical partial overloads;

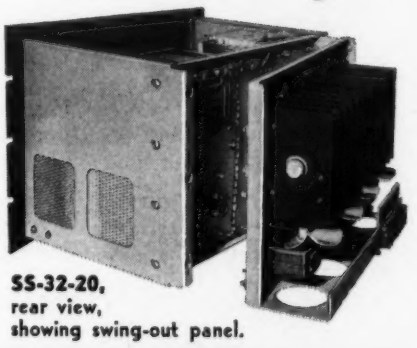
Because NJE "regulation" is the **total** of the **worst simultaneous combination** of line and load effects, static and dynamic;

Because NJE circuitry provides **stability,** against both time and temperature, **better than the rated regulation;**

Because we build all 14 standard models from three mass-produced "building blocks", **very competitively,** despite higher quality,

It follows that your best buy in a transistorized power supply is NJE SOLID STATE.

QED... choose NJE



SS-32-20, rear view, showing swing-out panel.

MODEL	VOLTS	AMP.	MODEL	VOLTS	AMP.
SS-7-15	0-7	0-15	TR-36-1	0-36	0-1
SS-10-10	0-10	0-10	SS-1603	0-160	0-1.5
SS-10-50	0-10	0-50	SS-1605	0-160	0-3.0
TR-18-2	0-18	0-2	SS-3600	10-36	0-50
SS-32-3	0-32	0-3	SS-1503	100-150	0-1.5
SS-32-10	0-32	0-10	SS-3003	200-300	0-1.5
SS-32-20	0-32	0-20	SS-1505	100-150	0-3.0

NJE CORPORATION

345 Carnegie Avenue, Kenilworth, New Jersey
CH 1-1500 TWX - Roselle, N. J. 51 FAX - FFP

For more information circle **25** on inquiry card.

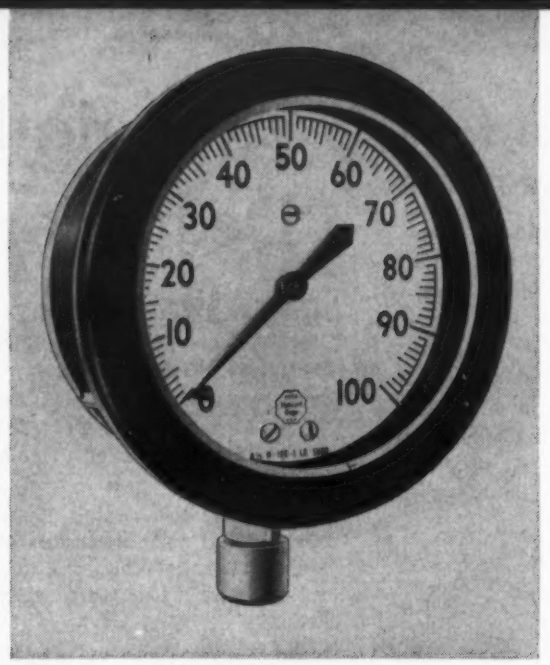


FIG. 1. CONVENTIONAL-appearing gage embodies many safety features required to minimize danger in liquid oxygen service.

New Instruments Required in Liq

E. H. GRAUEL, Helicoid Gage Division, American Chain & Cable Company, Inc

SINCE the impact of the first atomic bomb in Japan in August, 1945, nothing has excited the imagination of our civilization as have the guided missile and the rocket. Few people realize, however, the magnitude of the careful planning to avoid the inherent danger lurking behind every attempt to launch a liquid oxygen (LOX) and hydrocarbon-powered rocket.

Liquid oxygen, according to our chemists and scientists, is one of the better-known oxidizers. When it is allowed to contact kerosene or other hydrocarbons, it will set off an explosion if confined. If only partially confined, it will burn with fierce intensity to develop extremely high pressures.

Jels will often form in the LOX formulation. These jels are highly sensitive to the impact of metallic chips or other foreign bodies with diameters as small as 0.002 inches. In this respect LOX is much like nitroglycerine.

When it is not being used, liquid oxygen must be stored in the equivalent of very large thermos-type containers or bottles which are vented to the atmosphere. Great care must be taken when the mixture is being transferred or pumped to tanks located within a rocket or missile. All piping, valves and pumps must be cleaned and freed of hydrocarbon traces. If transferred by helium, rather than pumps, the helium and all instrumentation used in conjunction with the transfer must be clean and dry, and pressures must be carefully monitored.

Since LOX has a density of 1.14 and a normal temperature of minus 300°F., transferral by the helium method is simpler and safer. Because this inert and lower density gas is interposed between the liquid oxygen and vital handling system components, the pressure indicator and other instruments are not subjected to extreme cold temperatures.

New Instruments For LOX

During the past year, the Helicoid Gage Division has concentrated on the design and manufacture of pressure gages for LOX and allied services. No effort has been spared on the part of engineering and research to provide suitable products for these services, which in the main, must be produced to detailed customer specifications (Fig. 1).

The pressure element, within the indicating gage, is usually made of type 316 stainless steel. Since cleanliness is an important requirement, a special bleeding feature is incorporated for use in purging all internal surfaces. Should any liquid oxygen enter this unit, there must be no chips or foreign matter to cause premature firing and a resultant explosion.

Most rocket and missile engineers use ¼" stainless steel tubing for lines to the pressure gages and specify 7/16"-20 internal connections (AND 10050-4) on gages. Others use the special 7/16"-20 external connection (MS 33514). The 9/16"-18 Aminco connection is also a popular choice. Any of these connec-

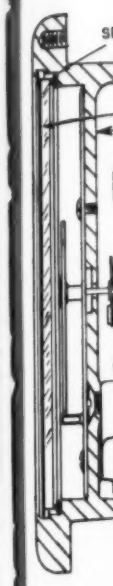
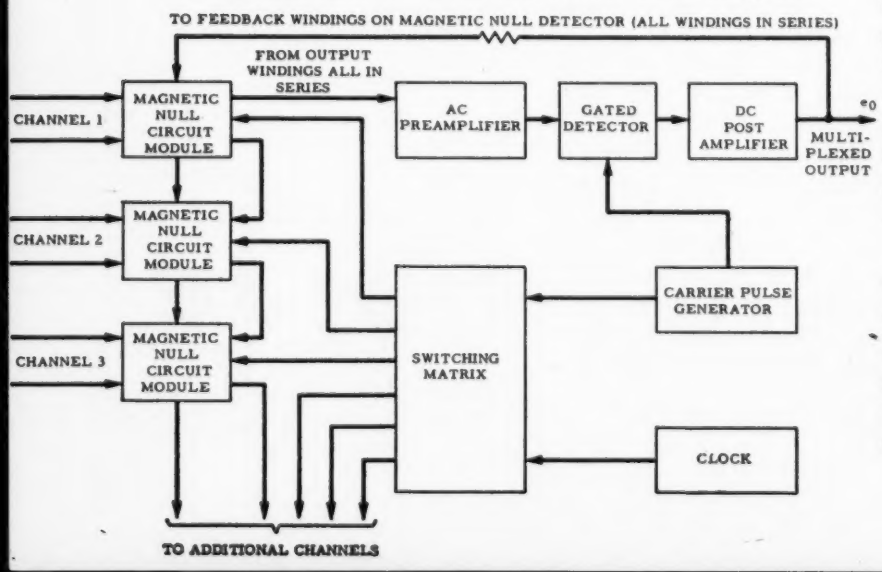


FIG
Gag
nect

Magnetic Multiplexer Is New Electronic Commutator

High-speed Multiplexing of strain gages, thermocouples, and potentiometers, without preamplification, in missile telemetry, aircraft logging systems and automatic checkout systems is being accomplished by means of a new system of low level commutation developed by the Cubic Corporation, San Diego 11, Calif.

MAGNETIC MULTIPLEXER, System Block Diagram.



The new device combines magnetic null detectors and transistor circuitry to achieve sampling rates to 5000 channels per second on a total of 1000 channels in a miniature 12-inch cube weighing only five pounds and consuming only 8 watts power.

The new magnetic multiplexer (See Figure) employs a subminiature magnetic null detector for each input channel. The null elements are turned on, one at a time, by a carrier switching matrix, and their outputs are series-connected to drive a single transistorized gated amplifier. Multiplexer output is derived from a major feedback loop which compares the amplifier output with the channel input level at each magnetic null detector by means of a feedback winding. The resultant channel gain is determined solely by the turns ratio of the input and feedback winding of each magnetic null detector.

Multiplexing is accomplished by switching the carrier to each null detector in turn, without interrupting the low-level signal lines. The minimum dwell time on each channel is determined primarily by the time required to smooth out ferro-magnetic noise, rather than by basic system rise-time considerations. A practical lower limit is 200 μsec, corresponding to a commutation rate of 5000 cps. And faster sampling rates to 50 kc, may be achieved by operating several sets of channels simultaneously, time interlacing accomplished by sampling their outputs sequentially.

The magnetic elements are basically current-sensitive devices, and input sensitivity is best specified in those terms. Typical Multiplexer designs provide full scale output of 5 volts with 50 μamps at the channel input. The input impedance for each channel is approximately 40 ohms, and series input resistance is normally added for range calibrations. Typically with a 120-ohm strain gage providing a 10 mv open circuit output, the total input channel resistance would be adjusted to approximately 200 ohms, to provide proper full scale calibration.

Accuracies of 0.1% to 1% of full scale output, depending on sample rate and temperature extremes are claimed for the new system. Shock and vibration capabilities are well within the requirements of space vehicle applications, and operation up to 100°C is expected by the fall of 1959. Systems for use in restricted temperatures such as those in aircraft flight test, can be furnished at the present time. Operating life in excess of 20,000 hours is anticipated. (*From 4-page bulletin, "The Magnetic Multiplexer", Cubic Corporation, 5575 Kearny Villa Rd., San Diego 11, Calif.*)

For this literature circle **84** on inquiry card.

...in Liquid Oxygen Systems

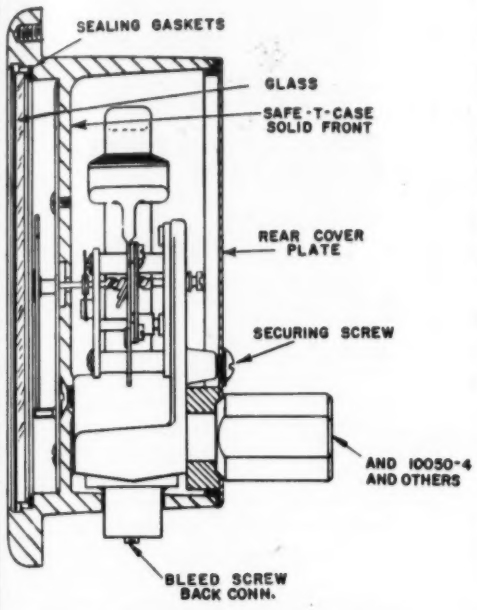


FIG. 2. SOLID FRONT Missile Gage construction with bleed connections.

tions, in addition to standard pipe thread, can be supplied on any type of pressure gage made by Helicoid.

When personnel must take frequent pressure readings from a LOX unit and stand close to the pressure indicator, Helicoid's Safe-T-Case Gage should be specified. These gages provide additional safety, particularly for the many unforeseen conditions which could arise.

Should an explosion occur, the operator is protected by a solid front wall in the case. Furthermore, if the Bourdon tube should corrode or rupture, the thin back of the case will deflect outward to permit the built-up and expanded gas to escape. The dial and glass on the unit's front, remain intact and undamaged.

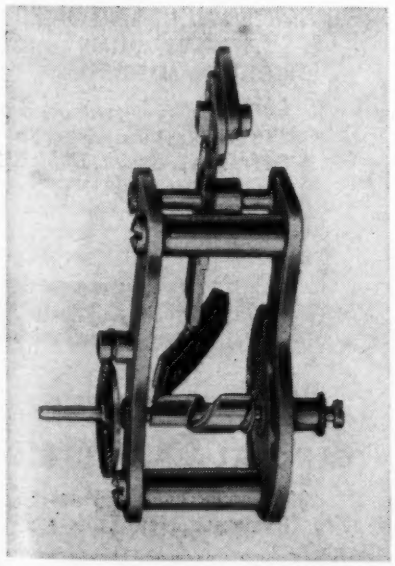
Design of the Safe-T-Case Gage departs from the usual gage construction. It consists of a solid metal front cover which is located between the gage dial and the Bourdon tube (Fig. 2). This wall, which is an integral part of the gage casting, is so designed that it diverts the escaping pressure towards the back cover. Under escaping pressure the back cover actually deforms to permit the internal pressure to escape from the case. The securing screw holds the cover in position at all times. A gasket seals the case from dust and dirt.

Equipped with the exclusive Helicoid movement, (Fig. 3) a simple cam and roller design, these gages can be purchased in 4-½ and 6-inch sizes with, and without, the bleed device. The cases are fabricated for flush or stem mounting, with back or bottom connections.

The rugged and unique Helicoid movement, proven ideal for dependability and accuracy, is designed to outmode the usual gage movement using spur gear teeth. Wearing and fouling of the teeth in geared mechanisms and excessive play between teeth have always been major sources of gear troubles. While a small cinder will lock or jam the teeth in a geared movement and dust will increase the friction, the wiping action of the cam facing across the roller surface in the Helicoid movement always tends to keep the contact clean and smooth. This movement can be furnished with right hand cam for service which might develop overpressure, or a left hand cam for service which might occasionally go into vacuum. Other desirable features, provided by the Helicoid cam and roller movement, are anti-fouling and resistance to wear when used under adverse climatic conditions and pulsating service.

Either type of movement and all other gage parts can be made fungus, humidity and salt spray resistant as specified in MIL-E-5272.

FIG. 3. CAM-ROLLER MOVEMENT eliminates spur gears with excessive play and friction due to dirt and dust. In this movement, lefthand roller helix releases cam from roller groove at minimum dial graduation, for protection against sudden vacuum.



For more information on Helicoid Gages circle **85** on inquiry card.

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☐ Send literature AND samples of STANPAT.

☐ Please quote price on our enclosed sketches which we are considering to have pre-printed by STANPAT.

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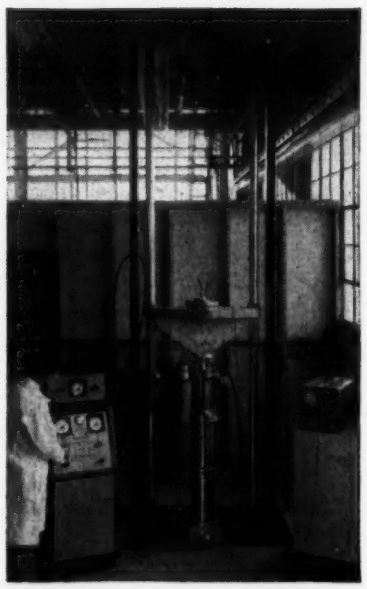
Only HYGE can produce and repeat so many different kinds of shock



60-second test simulates exact service conditions, records shock waves on oscilloscope for instant reference or photography.

What shock situation would you like to set up? Shock loads to missile launcher? Re-entry—to atmosphere, land or water? Rocket fuel handling? Parachute landing? Underwater or underground explosion? You can simulate them all with HYGE . . . and repeat each one exactly . . . for only pennies per test. And as new test requirements develop, an inexpensive metering pin adapts HYGE to meet them. You have a permanent source of stored energy—variable, to meet your needs, up to 40,000 lbs. thrust—with versatility for a wider range of shock wave patterns than with any other equipment. If shock is a factor in the success of your project, you'll want to know more about HYGE.

Write for Bulletin 4-70-A . . . theory, application and specification data on HYGE Shock Testers.

Consolidated Electrodynamics

Rochester Division, Rochester 3, N.Y.

SALES AND SERVICE OFFICES IN PRINCIPAL CITIES

For more information circle **27** on inquiry card.

PICKUP-STORAGE CAMERA TUBE

A NEW small-size "Permachon" camera tube, Westinghouse Type WX-3989 (Fig. 1), now combines standard vidicon operation with high resolution, long-storage continuous readout capabilities hitherto attained only by using an electrical-writing storage tube and associated circuitry as an auxiliary to a standard vidicon camera.

The Permachon may be used to view a radar or sonar display, integrating several sweeps, and then "freeze" the picture for study or photography. Such a picture will show trail patterns on the moving targets. Alternatively, the storage time of the system may be reduced to about 2 seconds to allow continuous presentation of new information while retaining the target trails effect. The Permachon also accepts electrical writing signals directly from the radar, making it possible to dispense with the original radar presentation.

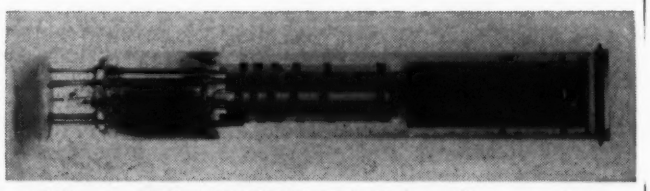


FIG. 1. PERMACHON TV Pickup/Storage tube combines functions of vidicon and storage tubes for which separate units have previously been required.

Operation — Image Storage Feature

The essential internal components of the Permachon are shown in Fig. 2. Fig. 3 shows a schematic circuit enlargement of a single resolution element of the target. It can be considered to be a capacitor paralleled by a leakage resistance, called the dark resistance, R_d.

As an example, the target supply potential is taken at 10 volts. The operation of a standard vidicon tube and of the Permachon is compared as follows:

1. With no light input, and after scanning of the target by the electron beam, point A is at 10 volts, B at 0 volts, and C is charged to 10 volts.

2. When there is an image input and beam is not present, R_d will decrease according to the amount of light on the element, voltage at point B will rise, and C will be charged to some voltage between 0 and 10. Then, after the image is removed,

   a) For the vidicon, a few scans will return point B to ground, thus charging up all elements of the target to 10 volts. This wipes off the image, returning the vidicon to Step 1.

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300 South Geddes Street
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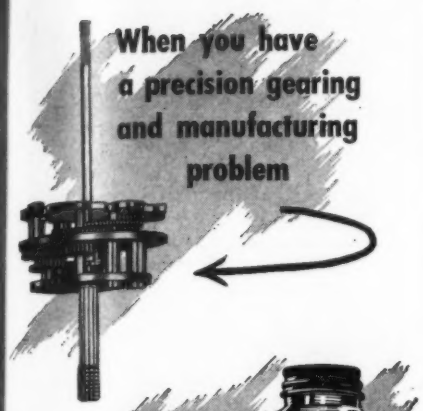
For more information circle **28** on inquiry card.



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b) For the Permachon, many scans will not substantially change the potential at point B. (Effectively, the electrons in the beam induce a change in R_d equivalent to that accomplished by the light image). Steps 3 and 4 pertain only to the Permachon.

3. To erase: a) If input is a relatively high-level light, R_d goes to 0, point B goes to + 10 and C is discharged to 0 volts.

b) If the beam is removed without light input, C will slowly discharge through R_d.

After 3, the target is "all white" and not capable of storing an image.

4. To Prime: Scan with the beam, bringing B to ground and C to + 10 volt potential. On the monitor, priming has the appearance of "wiping" the target, beginning at the edges and ending in the center. Time required to prime decreases as beam current is increased. The Permachon is then back to condition 1.

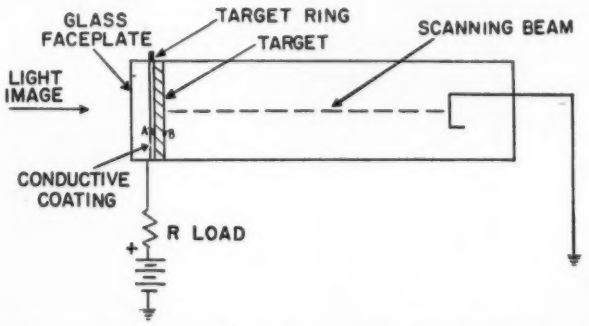


FIG. 2. SCHEMATIC representation of Permachon circuit resembles that of vidicon.

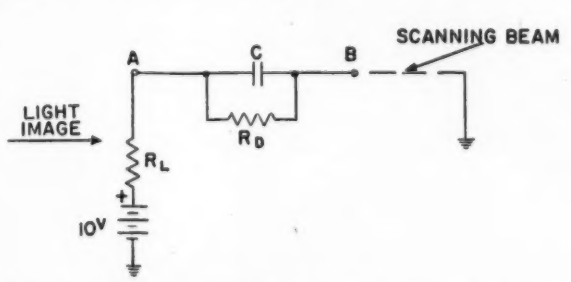
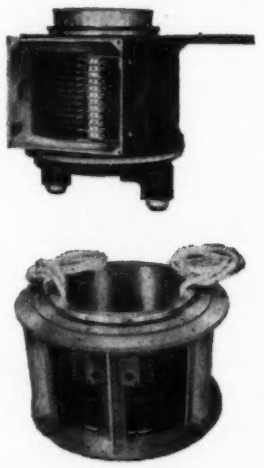


FIG. 3. SINGLE STORAGE element operation. Electron beam scanning in the Permachon does not change the charge on the target element, as in a vidicon.

Exposure time to store an image is a function of light level, requiring less than a millisecond at several hundred foot candles, up to about 60 seconds at 10^{-2} foot candles. Storage time may be varied from less than a second to nearly an hour with continuous readout, with a decrease in resolution and contrast noticeable with longer storage times. Resolution of 600 lines and eight shades of gray are maintained for approximately five minutes. The Permachon is a development of the Westinghouse Electronic Tube Division, P. O. Box 284, Elmira, N. Y.

For more information on Permachon circle **86** on inquiry card.

BREEZE SLIP RINGS



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MILITARY ELECTRONICS BOOKS

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For Book list circle **31** on inquiry card.

NEW DIMENSIONS IN LOW-COST AIR COOLING

EQUIPMENT COOLING, even for units into which a fan must belatedly be designed, is now simplified due to a new "Muffin Fan" which uses new materials and manufacturing techniques to achieve a quiet 100 CFM capacity in a volume only 1½" deep by 5" square. The shaded-pole, inverted type motor fan, shown mounted in a venturi block (Fig. 1) has been developed by the Rotron Manufacturing Co., Inc., Woodstock, N. Y.

When flushing an enclosure in which components dissipate heat, the temperature rise of the air when passing through the enclosure will be

$$\Delta°F = 3170 \times KW/CFM$$

where CFM is the amount of air moved as taken from the performance curve, and KW is the heat dissipation in kilowatts of components inside the enclosure to be cooled. The larger the allowable air temperature rise (Δ °F) through the enclosure, the greater the heat dissipation that can be handled by the fan. The new fan can be incorporated into cabinets where the bulk of a conventional fan could not be accepted.

The skeleton fan, which is available to equipment manufacturers for basic air-stirring applications, (Fig. 2) consists essentially of two parts. First, the motor stator with bracket arms contains the entire electrical structure. It is a completely encapsulated, one-piece, molded black assembly which is highly impervious to moisture, having four bracket arms reinforced with fiber-glass rods. Second, the rotor-impeller-shaft assembly consists of the rotor laminations and hardened steel shaft around which molten aluminum is centrifugally cast to form an accurately centered and balanced one-piece assembly, finished in baked enamel.

In designing the motor assembly, an outstanding use of new high-strength epoxies has been made in a component which traditionally has been assembled of separately cast, punched and machined parts. Older manufacturing methods were labor consuming, yet produced a motor which was susceptible to moisture, and dirt and which contained potential hot spots in the windings. Skillful use of epoxy encapsulation not only drastically reduces the labor needed to produce each motor, but also hermetically seals the windings against deterioration due to moisture and firmly supports the laminations to prevent abrasion of winding insulation due to lamination vibration. Air pockets and hotspots in windings are also eliminated, improving the reliability and life of the motors.

The Muffin Fan is designed for continuous duty operation with a life expectancy of three to five years when operated within ambient temperature limits of

FIG. 1. "MUFFIN" fan achieves a quiet 100 CFM capacity in only 1½" of depth.

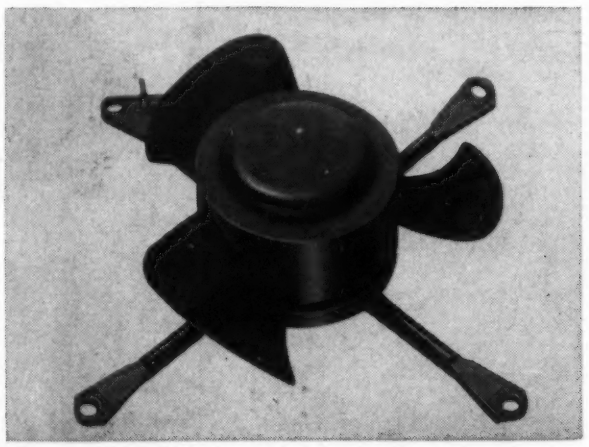

FIG. 2. SKELETON FAN is available for basic air-stirring applications in ambients to 110°F.

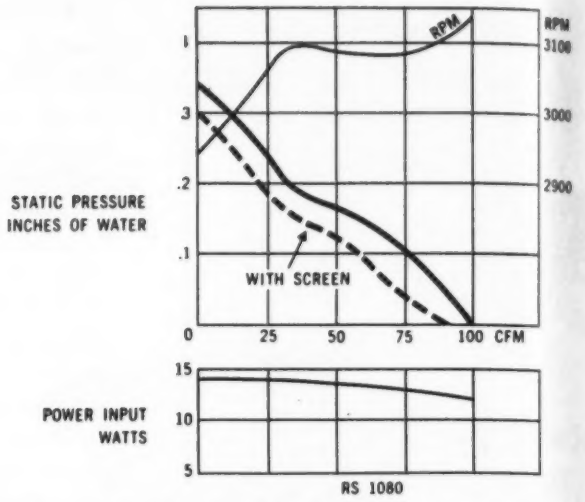

FIG. 3. PERFORMANCE CURVES of Muffin Fan.

FIG. 4. GRILLE reduces capacity only slightly, occupies virtually no additional volume.

40° to 110°F, and within the electrical limits of 105 to 120 v, 60 cps. It draws only 13 watts of power. Its performance is graphically illustrated by Fig. 3, which shows that it will deliver 100 CFM at free delivery and 85 CFM at 0.1" of water, static pressure. With the grille assembly in place (Fig. 4) these figures become 95 CFM for free delivery and 60 CFM for 0.1" of water, static pressure. For larger volumes of air, two or more Muffin Fans can be mounted in parallel.

Audio noise of the fan is rated at 42 db on the A scale, which is less than the conventional air conditioner. Electrical noise and RF interference with electronic circuits is completely absent, as no brushes, slip-rings or other electrical contacts are present to produce sparks. Solder terminals on one of the molded stator arms provide dust-free connections which conveniently extend up through holes in the epoxy Venturi block.

Typical applications seen for the Rotron "Muffin Fan" include: Electronic "black boxes" such as transmitters, receivers, radar, etc.: microwave-link equipment, ground based; power supplies such as rectifiers, converters, battery chargers; office machinery including computers, blueprint machines, duplicators; telephone equipment, including telephone booths; public address amplifiers, hi-fi equipment and enclosures, Tape recorders, police radio equipment, television cameras, slide and filmstrip projectors, contour projection; trailer, boat space and darkroom flushing; space heaters, to augment flow of heat; fireplaces, and microwave cooling; machine tool control enclosures, clutches; and industrial testing and maintenance equipment.

For this literature circle **89** on inquiry card.

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Novel Filter Tuner is Distortionless

Allison Variable Filters for noise analysis, frequency distortion measurements and band width control, consist of two low pass sections and two high pass sections in each unit. Switches control the low pass and high pass sections independently. Each position on the switch changes the cutoff frequencies by one octave. Any cutoff frequency desired in this octave may be obtained through the use of a multiplier dial which tunes the filter over the range of one octave, plus 20% overlap.

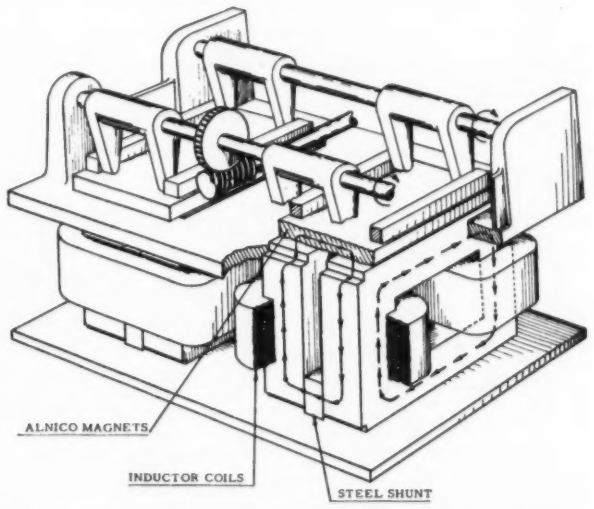


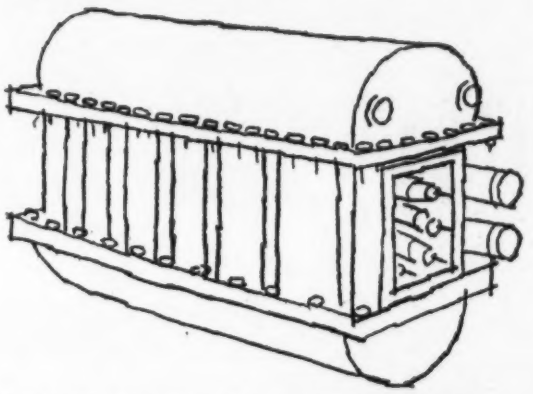
FIG. 1. MAGNETICALLY Controlled Tuning Inductor.

The tuning inductor used in these filters operates on an entirely different principle from any inductors previously available. In this inductor, the dc flux from a magnet which controls the actual inductance value of the inductor, flows at right angles to the ac flux from the inductor coil. The discontinuous lines (Fig. 1), consisting of arrows, show the direction of flow of the ac flux from the coils. The continuous lines of arrows show the dc flux from the magnet. At any given instant the ac flux is adding to the flux from the dc magnet in one of these cores and subtracting from the flux from the magnet in the other core in the same coil. This results in the cancellation of harmonics normally generated when a permanent magnet is used to control the inductance as has been done in saturated reactors. (Patent No. 2,719,276 and other patents applied for.)

Three standard Variable Filters, and a number of special combinations are available. The 2A filter, designed for 600 ohms impedance, and 0.5 watts maximum audio frequency power input covers frequencies from 15 cps to 10,080 cps in nine overlapping ranges. The 2B filter with same impedance and power ratings, covers frequencies from 60 cps to 20,160 cps in eight ranges. The 2C filter designed for 600 ohms, is rated at 2½ v maximum output. It covers frequencies from 9 kc to 640 kc in six overlapping ranges. (*From 8-page bulletin, "Allison Variable Filters," Allison Laboratories, Inc.,* 14185 *Skyline Drive, La Puente, Calif.*)

For this literature circle **88** on inquiry card.

A PROBLEM OF UTMOST GRAVITY



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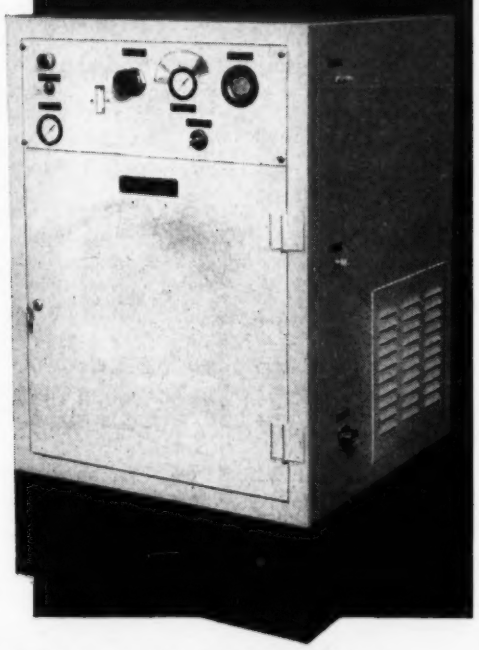

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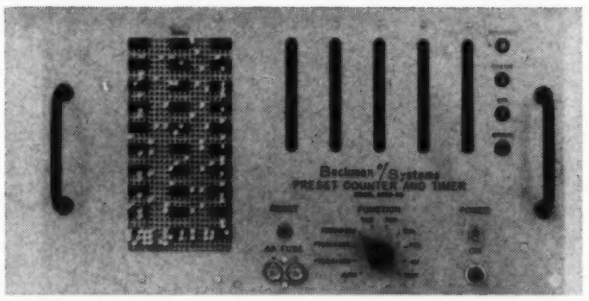
Frequency/Interval Monitor

TWENTY CHANNELS of information are continuously monitored on a GO/NO-GO basis in a new versatile Preset Counter and Timer, Model 5690-80, announced by the Beckman Systems Division, 325 No. Muller Ave., Anaheim, Calif.

Particularly applicable in automatic missile checkout systems, any output which can be translated into a frequency-variable output can be monitored and programmed to energize Go/No-go lamps to continuously indicate the missile's functional status. Twenty pairs of high-low limits may be preset by means of a pinboard which occupies approximately one third of the panel face, utilizing either frequency or time interval measurements. By external programming and multiplexing, more than 20 channels may be monitored.

The capabilities of the Counter and Timer include the measurement of sinewave frequency inputs from 10 cps to 1 million cps, and time intervals in milliseconds from 1 to 99,999.



Selection of the function (measure frequency, time or voltage) may be done by the counter front panel selector switch or externally by contact closures in the programmer. No relays are used in the counter for external function selection.

When used as a frequency measuring device, the 5690-80 counts pulses for 0.1, 1 or 10 seconds and displays the total on a bank of five decimal counting units. To arrive at frequency values, these counts are multiplied by 10, 1 or 0.1 to arrive at frequency in cycles per second.

When a frequency measurement is to be made, the signal to be counted is connected to the input jack. The period of the measurement is selected as 0.1, 1.0, or 10.0 seconds, depending on the range of the input frequency. A pair of limits, which previously have been plugged into the pinboard, may be selected externally. Activating the "Reset" will reset the counter, control circuitry, and the time base. The counter gate will open starting the sample time, approximately 10 milliseconds after reset. The input signal will be counted for the specified time, the gate will close stopping the count, and the count data will be displayed.

To make time interval measurements, the start count signal is entered as a positive- or negative-going pulse and stopped by either a positive- or negative-going pulse. The interval is counted in milliseconds and displayed on the decimal counting units.

The unit is available for research, and industrial as well as military systems applications, and additional technical information is said to be available on request.

For more information circle **87** on inquiry card.

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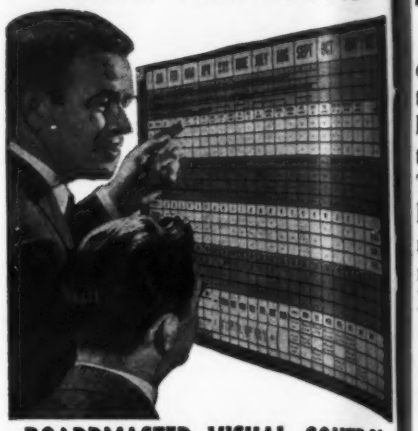

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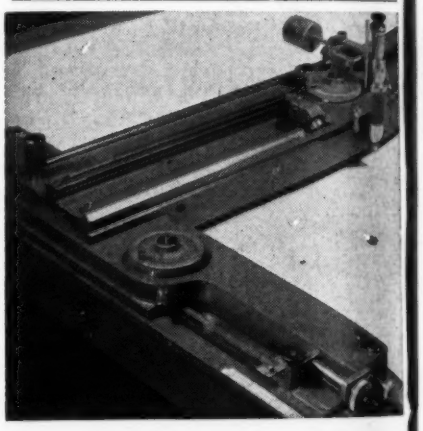

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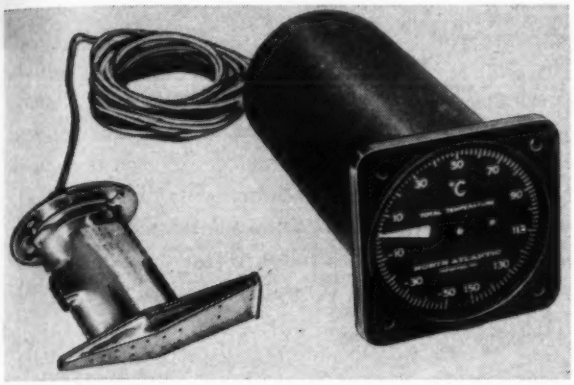
Custom Servo Instruments From Building Block Elements

Customized Instrument systems for airborne indicating and telemetry and for laboratory test applications now can be readily provided from a new line of building-block elements designed by the North Atlantic Industries, Inc., 603 Main St., Westbury, N. Y. The Total Air Temperature Indicator used on the Republic F-105 (Fig. 1) is a typical high accuracy, miniaturized application of this system. This instrument is shown with a Rosemount Engineering Co., Model 102, Air Temperature Probe.



The Model 102 Air Temperature Probe, a development of the Rosemount Engineering Co., 4900 W. 78th St., Minneapolis 24, Minn., permits precise total temperature measurements to mach 2 and higher, even while deicing heat is being applied.

The new system is based on a miniature position servo which mounts on the instrument panel to give a visual reading or shaft position proportional to the input voltage. Suitable scales, output potentiometers, synchros or encoders can be incorporated into the unit to meet virtually any aircraft or missile requirement for indicating or transmitting data. The system includes a zener reference diode with maximum accuracies to 0.05% of full scale, with highest full scale response time of less than 0.25 second.

Other instruments which can be provided in this series are ratiometers, millivoltmeters, tachometers and data repeaters for aircraft, missile and computing applications. Primary power, 115 v 400 cps, and signals are the only inputs required. Ratio measurements also require a dc input of 6 to 20 v power.

The use of building-block techniques enables the design engineer to provide instrumentation geared to exact operational or test needs without embarking on lengthy development programs or costly small-scale manufacture. The use of elements which are readily available from stock also saves procurement time and cost. Components used in experimental laboratory setups can be re-used and re-adapted to a wide range of dissimilar applications with minimum expenditure of time and money.

For more information on Servo Elements circle **90** on inquiry card.

For more information on Mod 102 Air Temp Probe circle **91** on inquiry card.

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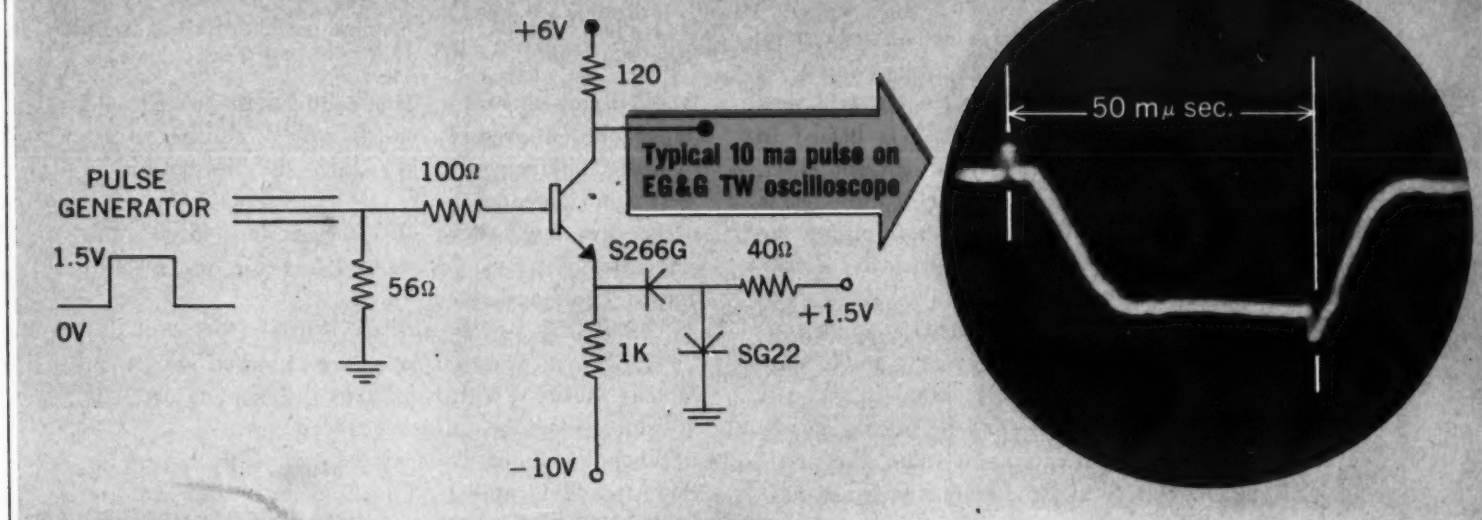
FIRST SILICON TRANSISTORS WITH 150 Mc Alpha Cutoff PLUS POWER



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Collector to Emitter Voltage — V_{CE}	15 Volts
Collector to Base Voltage — V_{CB}	15 Volts
Emitter to Base Voltage — V_{EB}	3 Volts
Total Power Dissipation: at 125°C Case Temperature	.5 Watts
at 100°C Amb. Temperature	0.5 Watts

SPECIFICATIONS AND TYPICAL CHARACTERISTICS AT 25°C

		Min.	Typical	Max.	Test Conditions
D.C. Current Gain	h_{FE}	10	20	—	$I_C = 10ma$, $V_{CE} = 6V$
D.C. Collector Saturation Voltage	V_{CE}	—	.5	0.6V	$I_C = 10ma$, $I_B = 2ma$
Collector Cutoff Current	I_{CO}	—	2	5μa	V_{CB} = Rating
Output Capacitance	C_{ob}	—	8	12 μμf	$V_{CB} = 6V$, $I_E = 0$ mA
High Frequency Current Gain	h_{fe}	5	7.5	—	$F = 20mc$, $V_{CE} = 6V$ $I_E = 10$ mA
Delay Time	t_d	—	6	mμsec.	
Rise Time	t_r	—	12	mμsec.	
Fall Time	t_f	—	10	mμsec.	

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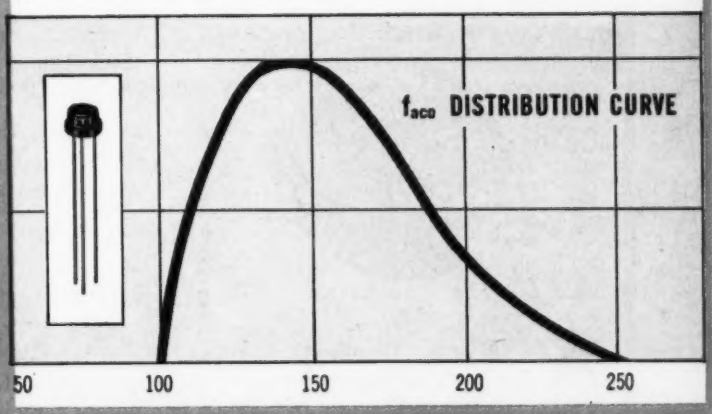

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SILICON PNPN CONTROLLED SWITCH

OPERATION of the 3A Series PNPN Silicon Controlled Switch can readily be understood by considering the analogy of two transistors, a high gain NPN unit and a low gain PNP unit (Fig. 1).

In this configuration, the collector current of the NPN unit feeds the base of the PNP, and the collector current of the PNP feeds the base of the NPN. This arrangement gives a positive feedback loop, and when the product B_1 B_2 reaches unity the system is self-regenerative.

Figure 2 shows the typical E-1 curve of the system.

With the base of the NPN transistor (Gate) reverse biased, only a small leakage current will flow from cathode to anode. (Junction #2 is biased in the reverse direction.) At this low current level, B_1 and B_2 are relatively low and their product is less than unity. This is the "off" condition of the forward characteristic in which the device has a very high impedance.

When a small forward bias current is applied to the base of the NPN transistor (gate), anode current (collector current of the two transistors) will rise, causing an increase in B_1 and B_2. As the anode current rises to a critical minimum value, the product B_1 B_2 reaches unity and the system becomes self-regenerative. When this occurs, the anode current increases rapidly, limited only by the external load. Once the regenerative action has started, the externally applied gate current no longer affects the system and it may be removed. This is the "on" condition of the forward characteristic in which the device has a very low impedance.

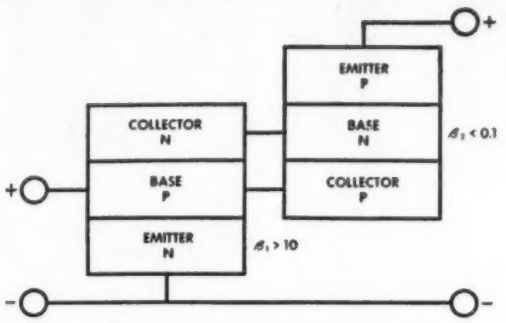


FIG. 1. PNPN SILICON Controlled switch (right) is esentially a combination of high gain NPN and low gain PNP unit (left).

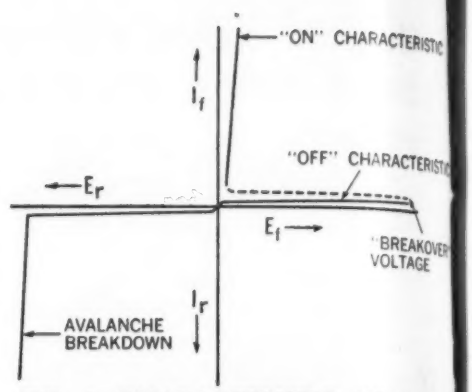


FIG. 2. CHARACTERISTIC "ON" and "OFF" states of Silicon PNPN Controlled Switch.

To turn the switch "off" once it has "fired", the anode current must be reduced to below the sustaining or "holding current" level.

The PNPN switch will also "fire" from "off" to "on", with no external gate current, when the anode voltage, positive with respect to the cathode, exceeds a value called the "breakover voltage".

When an anode voltage, negative with respect to the cathode is applied, Junctions #1 and #3 are biased in the reverse direction. The switch has a high impedance under this condition and behaves essentially the same as a conventional silicon diode in the reverse direction.

The Series 3A Silicon PNPN Controlled Switch, a development of Solid State Products Inc., Salem, Mass., has voltage ratings to 200 v and peak current ratings to 1 amp. Turn-on time of 0.2 μsec is typical. Current gains to 500 and power gains to 250,000 are possible at peak outputs to 1000 ma. Unlike transistors which require continuous input to stay "on", a momentary trigger pulse is sufficient to turn the PNPN switch to "on."

Some of the many possible applications include: Magnetic core switching, flip flops, logic circuitry, pulse generation and shaping, inverters, motor controls, regulated power supplies, servo systems and high level demodulators. They are particularly suited to A. C. static switching and control circuits.

3-D Functions Solved by New Analog Component

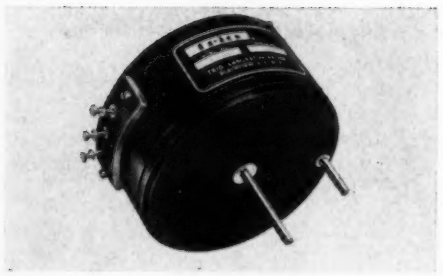


FIG. 1
RODIAC

An entirely new analog element, the Rotary Dual Input Analog Computing (RODIAC) element, is now available for use in analog computers which require the solution of the equation:

$$z = f(x, y).$$

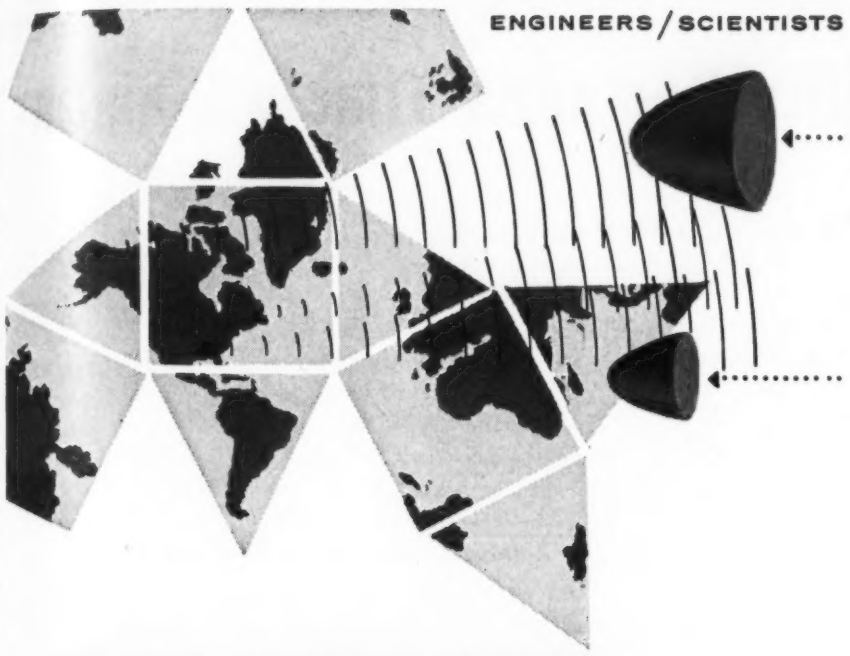
Heretofore solvable only by three-dimensional cams or complex servo-multiplying circuits, now arbitrary functions can be controlled from two independent inputs, using a single component similar in appearance and size to a precision potentiometer, although radically different in construction and application.

A photograph of the Rodiac is shown in Figure 1. There are two shafts protruding from the housing. These are the inputs to the unit which are independently controlled. Its output is electrical and may be any arbitrary function of the two mechanical inputs.

Principle of Operation

The "heart" of the Rodiac is a potential cylinder. The flat surface of the cylinder contains the potential plane over which a pick-off element travels. An electrical reference voltage, either ac or dc, is applied to the two end terminals. The device then distributes this applied potential over the plane surface in a manner determined by the given function. The two mechanical shaft inputs serve to position the brush relative to the potential surface, thus providing a pick-off voltage that is a function of the two independent variables. This voltage is made available directly at the third terminal and, of course, may be measured with respect to either end of the reference signal.

The techniques of distributing the potential field and enabling the pick-off to accurately and reliably transmit the output voltage have involved the integration of mathematical, chemical and electrical efforts as well as meticulous attention to detail in mechanical design. Basically the potential field is established by means of a series of equipotential lines, properly spaced and aligned to obtain maximum accuracy and compatibility with pick-off element motion. These lines are connected electrically by a resistive coating, developed specifically for the unusual requirements of the Rodiac. Each equipotential line is held at its fixed voltage by a chain of miniature precision resistors, soldered on a printed circuit board and cast



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HEAVY MILITARY ELECTRONICS DEPT.

GENERAL ELECTRIC

Court Street, Syracuse, New York

For more information circle **39** on inquiry card.

in epoxy compound to assure maximum stability and reliability of performance.

Applications

The Rodiac is useful in any computer operation in which a single-valued electrical output must be obtained as a pre-determined function of two inputs. In one typical application, a Rodiac potential cylinder can be designed to store the information representing the magnetic variation of the earth's field. The two shaft inputs are positioned for latitude and longitude, respectively. Then by rotating the center shaft to an angle representing the longitude and the outside shaft to the latitude of any point on the earth's surface, the voltage output represents the value of the magnetic variation at that location. This voltage is then available for use by the computer.

Another application of the Rodiac is in its use as a True Angle of Attack Computer. Angular positions of an angle-of-attack vane deviate from their true positions in an empirical relationship functionally dependent on mach number. When this data is determined for a particular aircraft model, the information is fixed by a Rodiac potential cylinder. If one shaft is positioned by the angle-of-attack vane and the second shaft rotated by the mach number computer, the electrical output will be proportional to True Angle-of-Attack. This indicates the possibilities of the Rodiac as a means for correcting or modifying one parameter as a function of another variable.

The excitation voltage applied to the end terminals also may be used to modify the output level in accordance with any desired function. Thus the solution of the equation $z = v\ f\ (x, y)$ where v is the excitation voltage applied, is readily obtained.

The Rodiac is housed in a standard potentiometer case. The unit illustrated has a 3″ diameter, is 1-7/16″ deep and weighs less than 7 ounces. Servo type mounting is provided although other methods of mounting are possible.

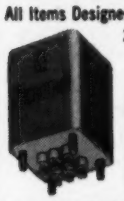
Applications of the Rodiac show distinct advantages: Of first importance in airborne applications, it is possible that two entire servo loops—including a separate package for a three-dimensional cam—may be eliminated. The compact size of the Rodiac may allow direct mounting into the computer itself. Also, system reliability is increased in proportion to the number of components eliminated.

Coupled with the decrease in size and weight is an increase in cost economy. By eliminating a great many design complexities, engineering costs, parts costs and field maintenance costs are all reduced. Another advantage of the Rodiac is the speed with which new models can be designed. Fewer man hours are required to translate new function data into working models, hence leadtimes are less and quick delivery may be more reliably offered, according to the manufacturer, Trio Laboratories, Inc., Plainview, L. I., N. Y.

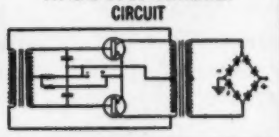
For more information on Rodiac circle **92** on inquiry card.

DC-DC CONVERTER

All Items Designed for 13.6V. Except 8034 which is for 28V Input.

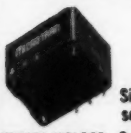


TYPICAL DC-DC CONVERTER CIRCUIT



Part Number	Total V.A. Output	D.C. Output F. W. Bridge Volts	Ma.	C.T. Full Wave Volts	Ma.
M8034	125	500	250	250	420
M8035	125	500	250	250	420
M8036	40	450	90	225	155
M8037	22.5	250	90	125	155

TRANSISTOR DRIVER



Designed specifically for transistor, servo and audio

Frequency response 70-20K

Size AF mill through AH Hermetically sealed to MIL-T-27A.

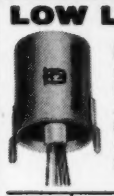
EPOXY MOLDED ON SPECIAL ORDER ONLY

See catalog for exact sizes and weights.

Part Number	Application	Pri. Imp.	Sec. Imp.	Pri. D.C. Unbal Ma.	Level Watts
M8002*	Coll. to P.P. Emit.	560	400 C.T.	18	.15
M8003*	Coll. to P.P. Emit.	625	100 C.T.	20	1.5
M8004	Coll. to P.P. Emit.	5,400	600 C.T.	15	.075
M8005	Coll. to P.P. Emit.	7,000	320 C.T.	7	040
M8006	Coll. to P.P. Emit.	10,000	6,500 C.T.	.75	.005

*Bi-Filar wound to minimize switching transients.

LOW LEVEL CHOPPER



Efficiently transfers 30 to 500 cps. Transducer or Thermocouple signals to instrument amplifiers. Signal level range from .5μV. to .5 volts. Resin impregnated to minimize mechanical vibration noise signal. Low hum pick up assured by 3 mu-metal and 2 copper shields.

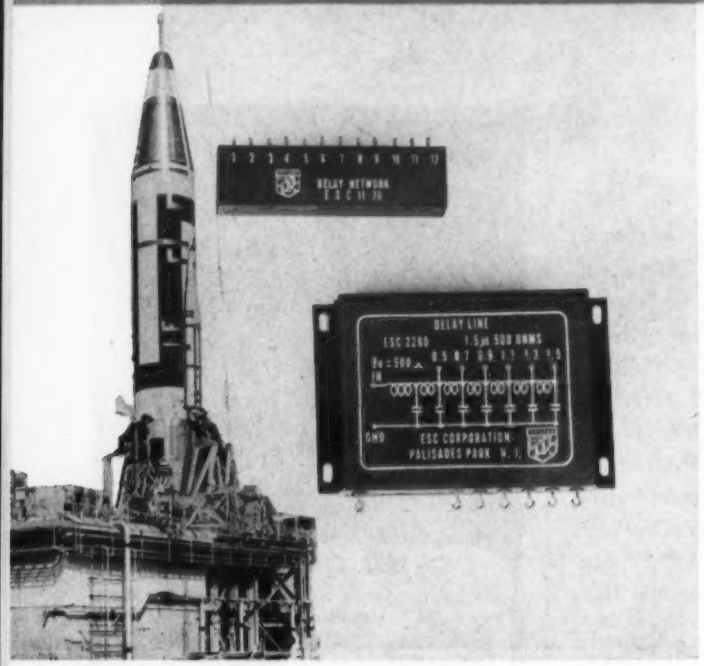
Part Number	Turns Ratio Full Pri. To Full Sec.	½ Pri. To Full Sec.	Ind. of Full Pri. @ .5V 60 Cycles	Imped. of Full Pri. @ .5V 60 Cycles
M8025	1:7.7	1:15.4	17.5	6,600
M8026	1:3.2	1: 6.4	60 Hy	22,500

Part Number	D.C. Resistance Full Pri.	Sec.	Mag. Shield.	Hght.	Dia.	Wt. Oz.
M8025	365	4140	90 DB	$1^{25}/_{32}$	$1^{3}/_{8}$D	4.5
M8026	455	3500	90 DB	$1^{25}/_{32}$	$1^{3}/_{8}$D	4.5

For more information circle **40** on inquiry card.

Missile Reliability Demands Timely Liaison

BERNARD BRAIN, Chief Engineer, ESC Corporation



SOPHISTICATED DESIGN techniques enabled use of networks with minimal number of components to improve reliability of the entire system.

At precisely Zero Hour, December 18, 1958, a giant Atlas ICBM roared off the launching pad, destined to become the world's first Talking Satellite. Circling the earth at 17,000 mph, it repeated a special Christmas message from President Dwight D. Eisenhower, erased it, and subsequently received and rebroadcast new messages in both voice and code.

Behind this giant step forward in the field of global communications lies an equally significant step forward in cooperation between the prime missile developer and the hundreds of suppliers of vital electronic components. We, at the ESC Corporation, who were so fortunate as to be assigned responsibility for the ICBM's delay lines, saw firsthand the value of the opportunity to offer our specialized knowledge early in the overall development of the Talking Satellite.

In today's tremendously complex missiles and rockets, the Systems Engineer must depend on the successful interaction of hundreds of specialized components, all designed and built by different manufacturers. A single component failure can—and too frequently has—resulted in costly setbacks to the nation's defense effort. Imagine the demands placed on individual components by physical stresses and strains of missile launching and flight, coupled with the electronic requirements of monitoring, correcting and reporting its own trajectory, and you will understand the necessity of perfection—and appreciate the difficulty of achieving it.

Reliability Results from Early Design

In a recent paper entitled "Contribution of Synthesis to Reliability—Optimum Ladder Networks" by Dr. Louis Weinberg, the need for designing reliability into equipment at very early stages is discussed. Cited as an example in this paper are certain circumstances leading to the use of a balanced filter with the consequent requirement of a push-pull amplifier instead of a properly designed single-ended filter and amplifier having half as many components, to obtain equivalent results. The prototype missile flew successfully, the design was promptly frozen, and the possibility of failure in this stage was doubled.

Very early in the development of the Atlas' electronic systems, we at the ESC Corporation were asked to sit in on engineering conferences and advise the Systems Engineer on both the application of delay lines *and* the relationship between our network and allied systems. As specialists with an intimate knowledge of the delay line field, we were able to make intelligent suggestions on associated circuitry and provide answers to many complex questions.

The performance specifications of pulse delay networks were carefully evaluated and the simplest methods of achieving the desired results were obtained. By utilizing sophisticated design techniques in the construction of networks having a minimal number of components, we were able to improve the reliability of the entire system. Complete encapsulation of the networks (Fig. 1) provided an additional safety factor and an exhaustive series of environmental tests confirmed "performance as specified."

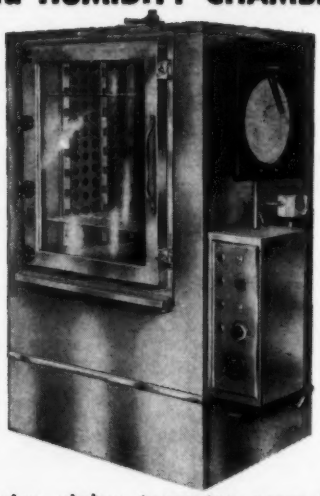
America's electronics industry is learning, by experiences such as this, that consultation between prime contractors and component manufacturers, as early in the missile's development as possible, is the only way to assure maximum reliability.

(*Typical performance characteristics of custom built delay networks and associated pulse components are available on request from E S C Corporation, 534 Bergen Blvd., Palisades Park, N. J.*)

For more information circle **93** on inquiry card.

Hotpack CONTROLLED ENVIRONMENTAL CHAMBERS
ENGINEERED FOR ELECTRONIC TESTING AND DEVELOPMENT

CONSTANT TEMPERATURE and HUMIDITY CHAMBER



Full view window, temperature ranges from 35°C to 100°C; 0°C to 100°C (Refrigerated) Temperature constancy within ± 0.5°C. Controlled humidity from 20% to 98% R.H. (5% R.H.) Designed for rapid, accurate testing and conditioning of semiconductors, printed circuits, filters and many other components. Engineered to meet requirements of JAN, ASTM and numerous test methods of MIL-STD 202 A. Through wall connectors, test leads built into unit on request. Sizes from 2 to 30 cu. ft.

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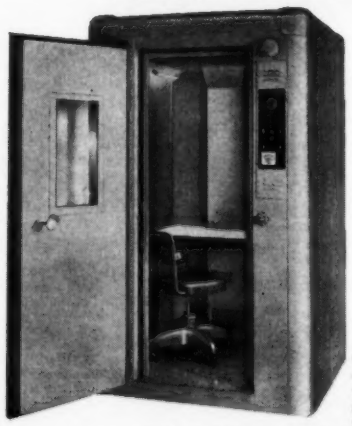

HEATED
REFRIGERATED
HUMIDIFIED
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Completely portable environmental room used for assembling electronic components and systems requiring controlled environmental conditions. Specially designed filter and air purifier provide dust free atmosphere for assembly operations. Double glass type windows for effective dust, air and moisture seal. Temperature ranges to 40°C or 125°C. Temperature controlled within ±0.5°C at control point. Higher temperature range allows room to double as test chamber. Humidity closely regulated from 20% to 98% R.H. within 5% R.H. Sectionalized prefabricated design permits assembly or disassembly of the entire room in a few hours. No blueprints needed for installation. Standard rooms may be equipped for recessed mounting. Room size easily expanded by insertion of center sections. Readily adaptable as computer housing facility. Write for list of sizes.

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RFC – M	1.0 μH to 1,000 μH	0.25 Dia. x 0.60 L
RFC – L	1.0 μH to 10,000 μH	0.31 Dia. x 0.90 L

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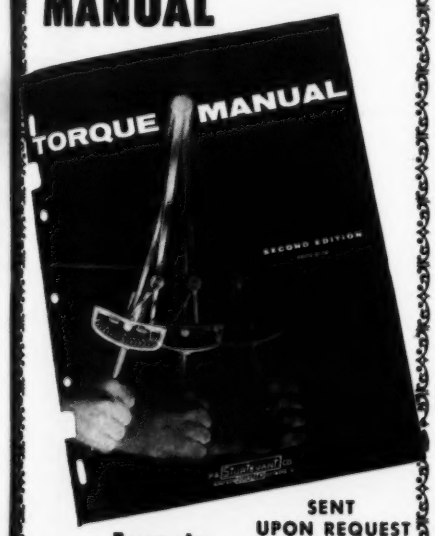
"TORQUE WRENCH" MANUAL



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Frequency Sensors Simplify Control Panel Design

Modern missiles and jets are outgrowing conventional dial-type panel meters by: (1) Demanding greater accuracy and reliability than can be provided by meters with moving part; (2) requiring faster and more accurate readings than can reliably be accomplished by humans; and (3) incorporating ever increasing numbers of meters to which a man must read and react, or must successfully coordinate with other men also reading and reacting to a mass of meters. In missile launching the more humans added to the control board the more chances for "inter-human" error.

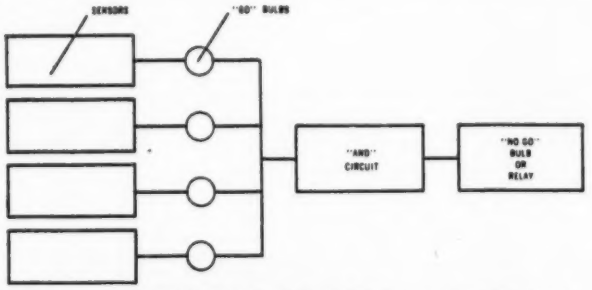

FIG. 1. INSTRUMENT SENSORS used with logic circuits reduce the number of signal lights to be monitored.

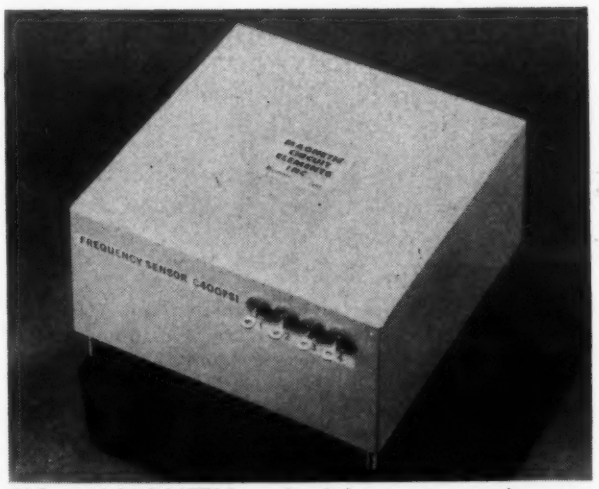

FIG. 2. MAGNETIC and solidstate circuit elements comprise Sensors.

New Instrument Sensors utilizing magnetic and static elements throughout, virtually immune to environmental extremes, and with accuracies of the order of 0.1% are engineered to provide "Go, No-Go" outputs in accordance with built-in tolerance limits (Fig. 1). Out-of-tolerance limits are presented with colored lights; green indicating "go" and red indicating "no-go". Also several sensors may be connected to an "and" or "or" logic circuit, eliminating the need for reading each electrical quantity individually.

Instrument Sensors (Fig. 2), which can be designed to measure ac or dc voltage, ac or dc current, frequency or other electrical quantities; may be located close to the source of the electrical quantity being measured, with only the indicating lights appearing on the control panel. (*From Information Bulletin, "Instrument Sensors," Magnetic Circuit Elements, Inc., 3722 Park Place, Montrose, Calif.*)

For this literature circle **94** on inquiry card.

DEVIATION MEASURED

10cps to 125kc

New FM Deviation Meter has carrier frequency range 4—1024Mc; crystal controlled LO enables measurement down to 10cps deviation. Used with a 'scope, it measures peak deviation of complex wave-forms. Very easy to operate, Model 791D ***speeds*** deviation measurements.

Carrier Freq. Range:	4—1024Mc, xtal locked
Mod. Freq. Range:	25cps to 35kc
Deviation Ranges:	0-5, 25, 75, 125kc.
Accuracy:	3%. Xtal standardized
Distortion:	Less than 0.2%
21 tubes:	6AK5, 6C4, 0B2, 5651, 6CD6G, 5Z4G, 5647, 6AS6

MARCONI INSTRUMENTS

111 CEDAR LANE • ENGLEWOOD, NEW JERSEY

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CHART-PAK precision tapes and die-cut symbols made these conductor paths and terminal pads for a printed circuit layout in 9 minutes 40 seconds!

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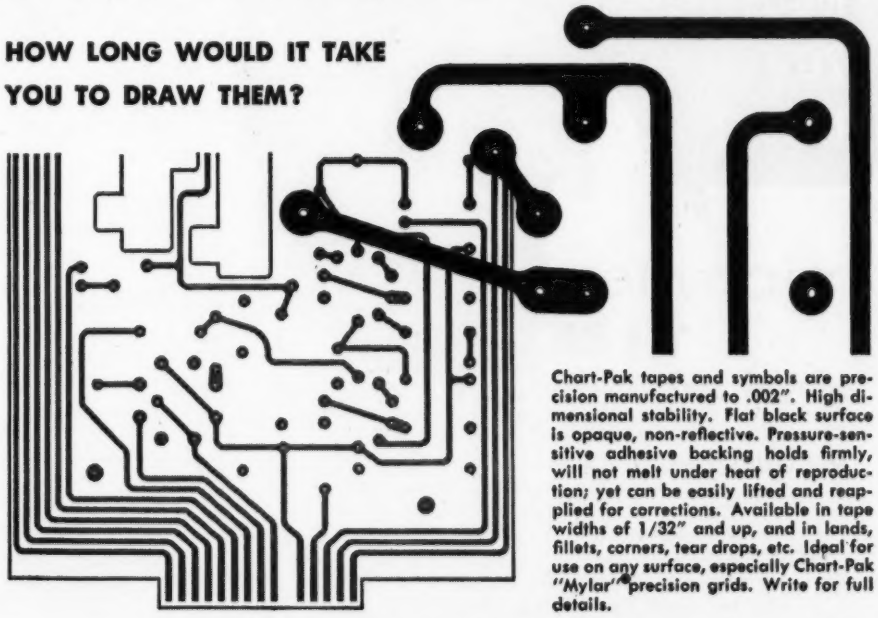

Chart-Pak tapes and symbols are precision manufactured to .002". High dimensional stability. Flat black surface is opaque, non-reflective. Pressure-sensitive adhesive backing holds firmly, will not melt under heat of reproduction; yet can be easily lifted and reapplied for corrections. Available in tape widths of 1/32" and up, and in lands, fillets, corners, tear drops, etc. Ideal for use on any surface, especially Chart-Pak "Mylar"® precision grids. Write for full details.

CHART-PAK Saves time... Saves money!

CHART-PAK, INC.

ORIGINATOR OF THE TAPE METHOD OF DRAFTING

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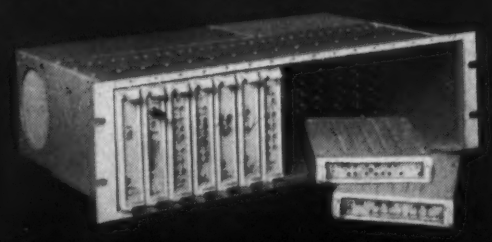
Harvey-Wells presents



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accuracy multiplied 20 times!

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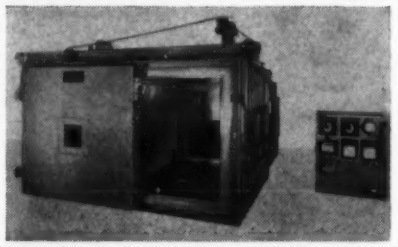
MSD new products

WALK-IN TEST ROOM

New 10′ x 8′ x 12′ test chamber for missile components tests, simulates altitudes to 100,000′, gives tempera-

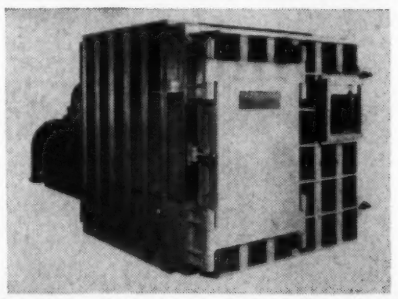


tures from —100°F to 300°F and relative humidities from 20 to 95%. Three-ton trolley-suspended door opens by pushbutton from either side. —*The American Research Corp., Farmington, Conn.*

For more information circle **95** on inquiry card.

HIGH-ALTITUDE CHAMBER

New Series 900 high-altitude simulation chambers are available in sizes from small lab units to "walk-in size",



simulate altitudes to 100 miles. Type 988 shown (6′x6′x7′) can be pumped down to 285,000′ altitude in 10 minutes, has locks for specimen introduction or removal.—*W. G. Overacker, General Vacuum Corp., 400 Border St., East Boston 28, Mass.*

For more information circle **96** on inquiry card.

PRESSURE TRANSDUCERS

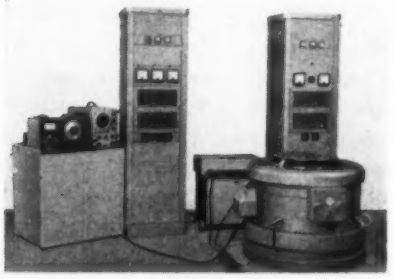
New Model L low-pressure transducers for severe environments are applicable to 20 G or more. Units are

oil-filled to eliminate internal resonances and extend life of potentiometer, aneroids and other moving components.—*Servonic Instruments, Inc., 640 Terminal Way, Costa Mesa, Calif.*

For more information circle **97** on inquiry card.

VIBRATION/FATIGUE TESTER

New testing system comprising Genisco-Savage Type 10K amplifier, V1001 Vibrator and type 1001 dc field

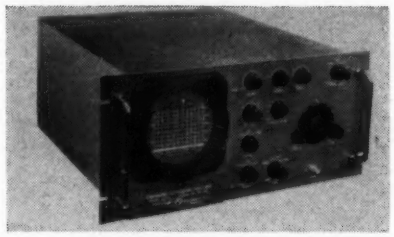


supply meets current MIL-specs for vibration and fatigue testing. Also is variable frequency power source for high intensity noise levels over "white noise" spectrum. Complete specifications on request.—*Genisco, Inc., 2233 Federal Ave., Los Angeles 64, Calif.*

For more information circle **98** on inquiry card.

PRECISION SPECTRUM ANALYZER

New compact Panoramic Model SB-15 Ultrasonic Spectrum Analyzer combines precision and high resolution in 8¾" high panel mounting unit.

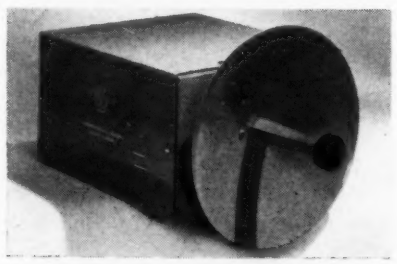


Covering frequencies from 100 cps to 525 kc, it offers continuously calibrated sweeps from 200 kc to 1 kc wide, 100 cps resolution, and variable sweeps from 1 cps to 60 cps.—*Panoramic Radio Products, Inc., 514 S. Fulton Ave., Mount Vernon, N. Y.*

For more information circle **99** on inquiry card.

VARIABLE POLARIZATION ANTENNA

Model 157 X-band Variable Polarization Antenna is motor driven, re-

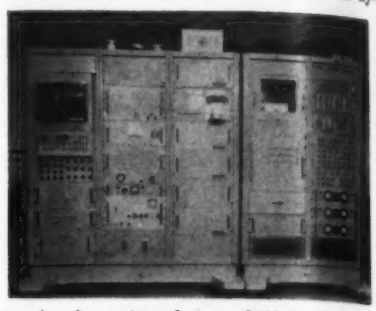


mote controlled to indexed stops at 0°, 45°, 90° and 135°. 8½" dia parabola.—*California Technical Industries, Div., Textron, Inc., 1421 Old Country Rd., Belmont, Calif.*

For more information circle **100** on inquiry card.

UNIVERSAL TESTER

Automatic Checkout Tester, based on Systron universal digitizer and limit comparator, is now in standard production for rapid evaluation of dy-

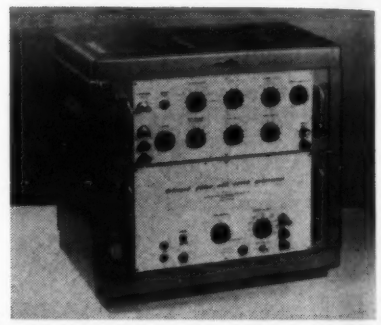


namic functional capabilities of any electronics system, sub-system or components without manual surveillance. Features IBM card automatic programming, 1000 inputs, and provides complete printed record.—*Systron Corp., 950 Galindo St., Concord, Calif.*

For more information circle **101** on inquiry card.

RADAR TEST SET

New 200 mc Radar Test set provides day-to-day pulse envelope comparison, spectrum analysis, etc. Used

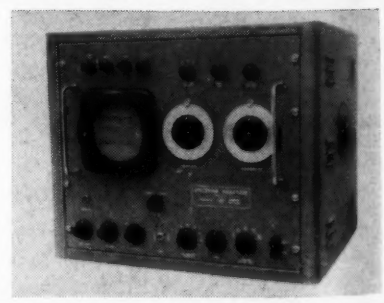


with Marconi 1000 watt rf absorption power meter, it checks out radar without radiating signal. Built to Mil-Specs.—*Marconi Instruments, 111 Cedar Lane, Englewood, N. J.*

For more information circle **102** on inquiry card.

SUBSONIC—SONIC ANALYZER

New Model SS-5 low frequency, high resolution analyzer is designed to give a fourier analysis of all signals in the 1 cps to 5.3 kcs range and si-



multaneously measure frequency and amplitude of each. Includes continuous variable tracked sweep width, sweep rate and gain compensation to give automatic optimum resolution.—*Probescope Co., Inc., 8 Sagamore Hill Drive, Manorhaven, L. I., N. Y.*

For more information circle **103** on inquiry card.

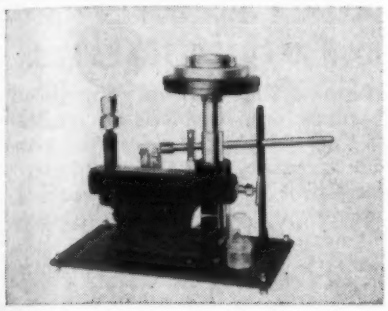
"PACKAGED" TEST FACILITIES

Complete environmental test facilities to simulate stresses affecting ultra-high-speed aircraft and space vehicles will be designed and constructed to customer's needs in aircraft and missile industries. New Company, affiliated with MB Mfg. Co. pioneer in environmental testing, offers new "packaged" service.—*Propulsion Test Facilities, Inc.*, 781 *Whalley Ave., New Haven* 8, *Conn.*

For more information circle **104** on inquiry card.

BI-FLUID PRESSURE TESTER

New Type 472 deadweight pressure tester uses pure water as hydraulic fluid entering gage or unit under test, while permitting use of lubricat-



ing oils in the piston-cylinder for most accurate, sensitive measurement. Water used is easily removed and never re-used to prevent contamination. Accurate to 0.1%, the BI-FLUID tester is available in capacities from 200 psi to 10,000 psi.—*Amthor Testing Instrument Co., Inc.*, 45-53 *Van Sinderen Ave., Brooklyn* 7, *N. Y.*

For more information circle **105** on inquiry card.

STANDARD RACK CABINETS

New FT-192 cabinets of formed construction for heavier components fea-

ture lift-out doors, removable end panels and integral blower systems, in choice of metals and finishes.—*Falstrom Company*, 301 *Falstrom Court, Passaic, N. J.*

For more information circle **106** on inquiry card.

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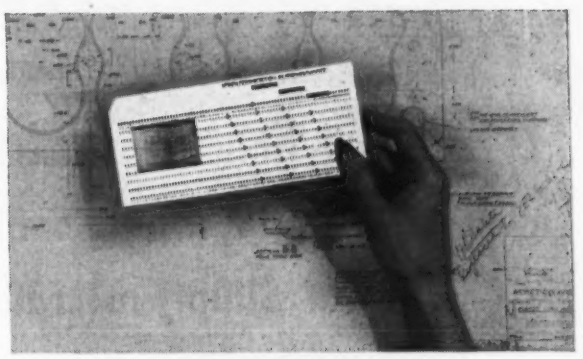
Save up to $500,000 yearly with a unitized microfilm system for storage and rapid reproduction of engineering drawings...



Above, original drawing is contrasted with microfilmed reduction mounted in aperture of data-processing card.

Left, Copyflo 24 continuous printer.

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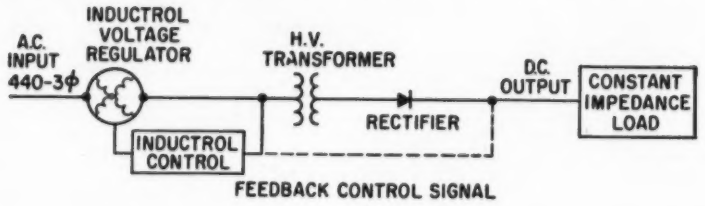
For more information circle **48** on inquiry card.

GENERAL ELECTRIC VOLTAGE REGULATION IDEA FILE

By C. A. NEUMANN

FOR RADAR ENGINEERS

Using General Electric Inductrol* Regulators in the high-voltage power supply of radar systems



Because the high-voltage power supply is an inherent part of the transmitter portion of a radar system, there is much concern over keeping the system effectively and continuously operative despite voltage control problems.

The diagram above illustrates how General Electric Inductrol regulators help solve this problem.

With the regulator in the circuit, as shown, it is possible to regulate the power supply output voltage while combining both the run-up function and the precise voltage control function.

ANY DESIRED RANGE OF VOLTAGE CONTROL for the system can be incorporated into this single regulator. In addition, the Inductrol voltage regulator, through its associated controls, corrects for input voltage variations and fluctuations of the load, while compensating for regulation of the circuit and changing characteristics of the rectifier element.

For reliable operation of the high-voltage power supply, the Inductrol regulator must provide the desired range of d-c power required. Problems such as line voltage variation, load changes, infinite d-c level requirements, being able to withstand high fault currents, and system regulation must be accomplished reliably and automatically for continuous operation of the power supply.

AS AN EXAMPLE, *here is a typical high-voltage power supply with the following requirements: d-c voltage—18 kv max., d-c current—1.7 amps max. Line voltage variation ±10%, d-c output voltage to be adjustable from 2 kv to 18 kv. System characteristics are: power factor—90%; efficiency—95%, system regulation—10%.*

TO OBTAIN VOLTAGES OF 2–18 KV with your three-phase bridge rectifier, the Inductrol regulator will vary the 440 V, three-phase input on the transformer primary in direct proportion to the H.V. requirements. In addition, it will automatically compensate for line voltage variations, load changes, and system regulation while being able to withstand fault currents of 25 times normal (for 2 seconds) and giving infinite voltage adjustment from 2 to 18 kv. This is accomplished without having the control device introduce waveform distortion, is free from contact maintenance (no brushes or switch contacts) and maintains ±1% accuracy over the full range. Inherently, the Inductrol regulator, whether dry-type or liquid-filled design, is virtually free from maintenance requirements.

OTHER INDUCTROL REGULATOR USES: Line voltage correction (60 or 400 cycle) control of filament power supplies, focus coil control, and grid voltage control in radar systems, variable speed antenna drives, computers, and many other electronic equipments.

FOR MORE INFORMATION, write to Section 425-20, General Electric Company, Schenectady 5, New York.

*Registered Trademark of the General Electric Company for Induction Voltage Regulators.

Progress Is Our Most Important Product

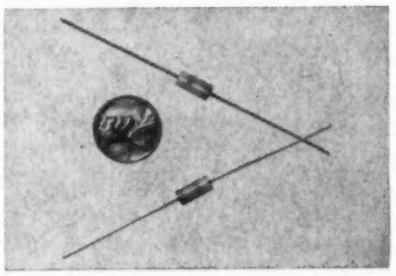
GENERAL ELECTRIC

For more information circle **49** on inquiry card.

New Products—CONT.

MINI SELENIUM RECTIFIER

New low cost type SP7K selenium rectifier meets environmental Mil-



specs with operation to 125°C. Available in 10-30 v and 40-80 v ranges. Spec sheets available.—*Bradley Laboratories, Inc.*, 275 *Walton St., New Haven* 11, *Conn.*

For more information circle **107** on inquiry card.

25-AMP POWER TRANSISTOR

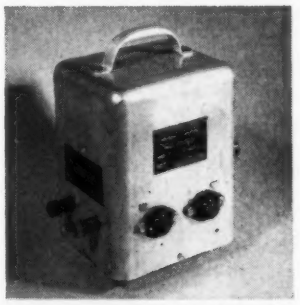
TRANSISTOR TYPE NOS.	2N1162 2N1163	2N1164 2N1165
Coll. to Base Voltage	50 v	80 v
Coll. to Emitter Voltage	35 v	60 v
Coll. dc current	25 amp	25 amp
Max Junction Temp.-Cont.	90°C	90°C
Max Junction Temp.-Intermittent	100°C	100°C
Collector Dissipation Base Temp. 30°C	50 w	50 w

New line of germanium PNP alloy junction power transistors meeting MIL-T-19500A requirements have almost twice current rating of other units commercially available; are said to exhibit good Beta linearity. Designed for high current switching and audio applications, in hermetically sealed TO-3 package with collector common to case.—*Motorola Inc., Semiconductor Products Div.*, 5005 *E. McDowell Rd., Phoenix, Ariz.*

For more information circle **108** on inquiry card.

SOLID STATE INVERTER

New S.I.C. Model 12-115-60AC series static inverters provide frequency stability over ±60% of input voltage, also gain high reliability and efficiency to 95% by eliminating VR

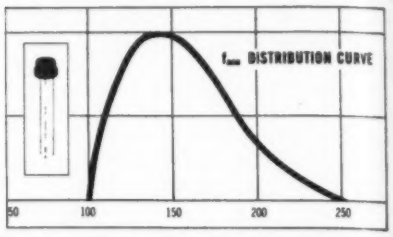


devices. One output winding supplies standard ac motors, etc., while second winding operates equipment with high-voltage dc supplies which charge to peak ac rectified voltage. 175 va continuous, over —40° to 70°C range.—*Static Inverters Corp.*, 2501 *E. 68th St., Long Beach, Calif.*

For more information circle **109** on inquiry card.

FAST SILICON TRANSISTOR

New 2N1139 silicon logic transistor has speed equalling that of fastest germanium types, averaging less than



30 millimicroseconds. Guaranteed Alpha cutoff is 100 mc minimum. Specifications sheet PB13 on request.—*Transitron Electronic Corp., Wakefield, Mass.*

For more information circle **110** on inquiry card.

SILICON ALLOYED TRANSISTOR

Four new PNP silicon alloy junction transistors, hermetically sealed in JETEC 30 packages, are said to provide greater reliability and performance through high conductance and uniformly low input impedance (35 ohms), operate at junction temperatures to 150°C, dissipate 150 mw at 25°C.

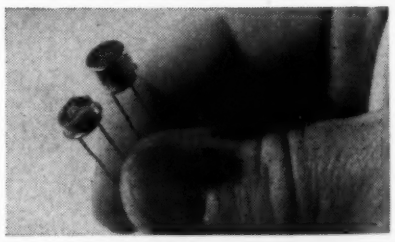
Transistor Type No.	Collector Volts	Min. Current Amplif.	Alpha Cutoff Frequency
2N1024	—15 v	9 min	1 mc min
2N1025	—35 v	9 min; 18 max	1 mc min
2N1026	—35 v	18 min; 54 max	2 mc min
2N1027	—15 v	18 min	4 mc min

Catalog data sheets on request.—*Sperry Semiconductor Div., Sperry Rand Corp., So. Norwalk, Conn.*

For more information circle **111** on inquiry card.

SILICON SWITCH DIODE

New Type AD 4-layer diode is turned on by voltage pulse, off by reversing or dropping current. Capable



of handling 300 ma dc or 20 amp pulse, four diodes in series will switch 800 v, for 16 peak kw in magnetron pulsing, etc.—*Shockley Transistor Corp., Stanford Industrial Park, Palo Alto, Calif.*

For more information circle **112** on inquiry card.

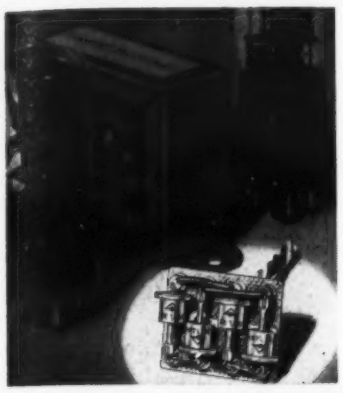
750 MC MESA TRANSISTOR

New germanium diffused-base "mesa" transistor has alpha cutoff frequencies up to 750 megacycles and power dissipations to 750 mw; operates at junction temperatures to 100°C in welded JETEC TA-5 package.—*Texas Instruments, Inc., P. O. Box* 312, *Dallas, Tex.*

For more information circle **113** on inquiry card.

SILICON RECTIFIER ASSEMBLY

New miniature silicon bridge rectifiers occupy only 1/10 volume, weigh less than 1/60th of equivalent tube

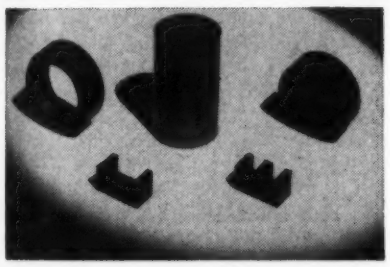


circuitry. Operate up to 165°C, 50 to 600 PIV, 50 ma to 1.2 amp. dc. Data in bulletin SR-207.—*International Rectifier Corp.*, 1521 *E. Grand Ave., El Segundo, Calif.*

For more information circle **114** on inquiry card.

MEDIUM FREQUENCY FERRITE

New ferrite MN-31, with high initial and maximum permeabilities, and high saturation magnetization has low losses in the 10-500 kcs range. High

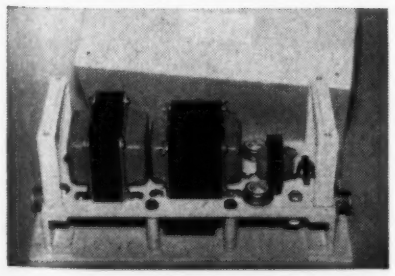


resistivity prevents eddy current losses, also has low hysteresis loss, Curie temperature over 180°C, low magnetization constant, and uniform high quality. Characteristics on request.—*Kearfott Co., Inc.*, 1500 *Main Ave., Clifton, N. J.*

For more information circle **115** on inquiry card.

SERVO AMPLIFIER

Rugged Model AS-20 servo amplifier using solid-state circuitry will withstand 2500% overvoltage input,

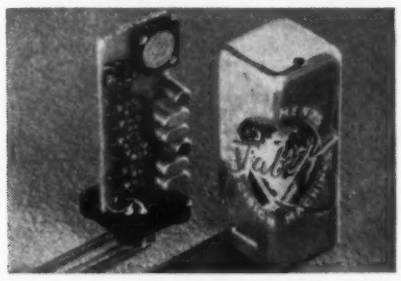


not be damaged by loss of load. Operates from synchro control transformer input in 60 cps servo system to drive 20 watt servo motor within —55° to 55°C range. Meets Mil-E-5400.—*Di/An Controls, Inc.*, 40 *Leon St., Boston, Mass.*

For more information circle **116** on inquiry card.

TRANSISTOR AMPLIFIER

New plug-in transistor amplifier unit Model 198S (silicon) designed for servo and audio applications, fea-

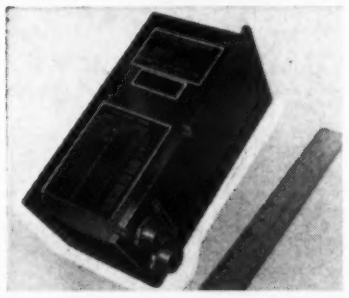


tures good closed-loop stability from —60° to 150°C. Open loop gain is 90 db with closed loop gain variable from 2 to 1000. Bandwidth is 5 cps to 50 kc.—*Taber Instrument Corp., North Tonawanda, N. Y.*

For more information circle **117** on inquiry card.

DC-DC CONVERTER

New static converter provides multiple output voltages, 150 watt max from 28 v dc input for airborne, test



and emergency equipment. Unit is insensitive to physical orientation, has efficiency over 75% and provides line regulation less than ±1%.—*Magnetic Research Corp., Hawthorne, Calif.*

For more information circle **118** on inquiry card.

CALIBRATION FACILITY

Model 10 Test Equipment Cart supports Model 829 AC-DC Instrument Calibration Standard and Model 150 Variable Frequency Power Supply,

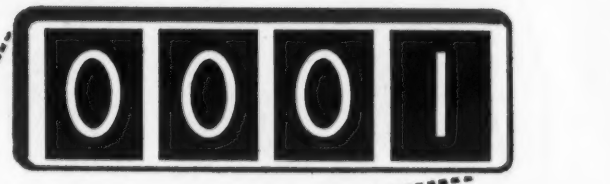
comprising complete portable electrical instrument calibration facility for operation from 115-v 60 cps line. —*Radio Frequency Labs., Inc., Powerville Rd., Boonton, N. J.*

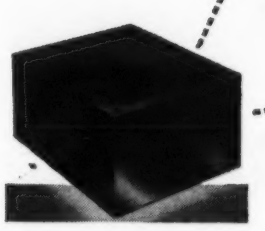
For more information circle **119** on inquiry card.

The NEW *Series* BH100

MILLI-V-METER

DIGITAL READOUT

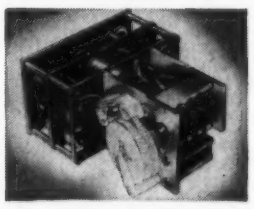




SMALL SIZE — This compact, transistorized, servo-driven instrument measures only 3 x 5 x 5¾".

ACCURACY 0.1%

THE INSTRUMENT with the TAPE-SLIDEWIRE

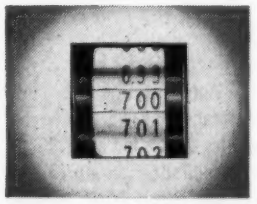


ALL INCLUSIVE—With Zener reference, power supply, amplifier, servo motor, 144" tape-slidewire.

Highly accurate digital display of

VOLTAGE · CURRENT FREQUENCY · POWER RESISTANCE · R.P.M.

TAPE-SLIDEWIRE — Mounted on side-by-side spools, slidewire is embedded in edge of tape, punched for sprocket drive.



PRINTED READOUT—Calibration printed on tape available to measure steady-state conditions or where input deviates more than 13%.

Every discrete scale unit is a calibrated point.

100 calibrated points per foot of slidewire length.

Slidewire up to 12 feet long.

LINEAR, PARABOLIC, LOGARITHMIC FUNCTIONS DISPLAYED IN DIRECT DIGITAL RELATION...COMPOUND RANGES, PLUS & MINUS SCALES FROM ZERO, SUPPRESSED RANGES

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b&h

Full information is available for the asking:

B & H INSTRUMENT CO., INC.

3479 West Vickery Blvd. • Fort Worth 7, Texas

Sales-Engineering Offices: COMPTON, CAL., VALLEY STREAM, L. I., N. Y., DAYTON, OHIO

For more information circle **50** on inquiry card.

New CPI

PLUG-STAT®

TWO WIRE HERMETICALLY-SEALED

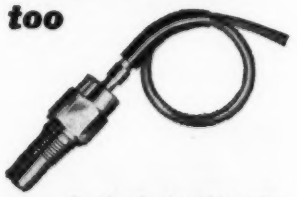
- **NO DRIFT**
- **RUGGED**
- **CLEAN MAKE AND BREAK**

Extreme shock, vibration and other severe environmental conditions will not affect the precise thermal indication of this new CPI hermetically-sealed thermal sensing switch. The new Plug-Stat® is a two-wire, rugged unit with stainless steel welded body and special alloy contacts that make and break *fast* and *clean* at set limits *without drift of calibration.*

This new Plug-Stat® operates accurately in environmental temperatures from minus 65°F. to plus 700°F. and is capable of a 200°F. overshoot from the specified operating temperature. Calibration temperature range from minus 20°F. to plus 700°F. is factory set to a specified tolerance and sealed.

Where you require an extremely sensitive response to high or low temperatures, this new non-drift thermal switch will fit your needs.

Ask about the* SINGLE-WIRE PLUG-STAT,® *too



Another in the CPI family of thermal switches is this single-wire Plug-Stat® for applications where required temperature range limits are minus 20°F. to plus 600°F.

Write now for complete engineering data. Ask for Catalog MS.

Control **products, inc.**

665 **HARRISON, N. J.**

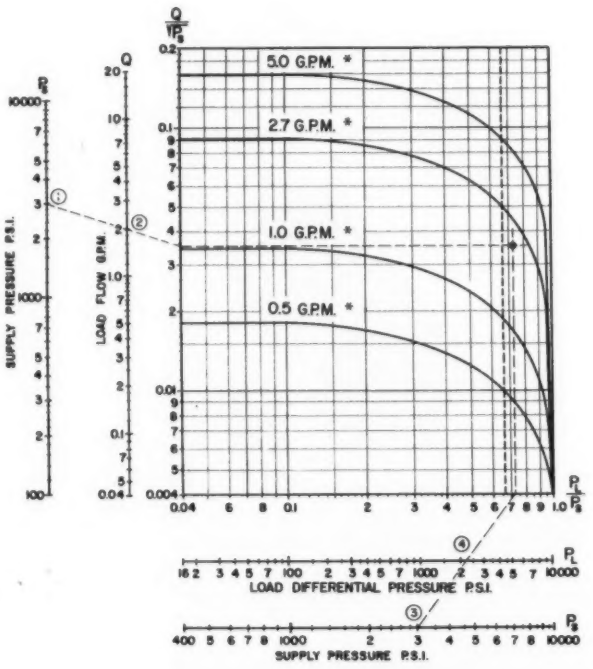
For more information circle **51** on inquiry card.

Nomograph Determines Servovalve Application

The Nomograph relates the variables in the following equation for each of four standard stock sizes of Servovalves.

$$\sqrt{\frac{Q}{P_s}} = K\sqrt{1-\frac{P_L}{P_s}}$$

The following load conditions and supply pressure are plotted as an example (dashed line) on the nomograph: $Q = 2$ GPM; $P_s = 3000$ psi; and $P_L = 2200$ psi.



*Rated flow at 1000 psi drop across the valve.

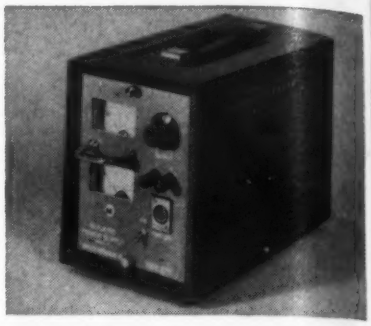
This condition is plotted as follows: Referring to the vertical scales on the left of the nomograph, draw a line from the supply pressure (1) through the load flow (2) to its intersection with the Q/P_s axis. Draw a horizontal line as shown. Referring to the horizontal scales, draw a line from the supply pressure (3) through the load differential pressure (4) to its intersection with the P_L/P_s axis. Draw the vertical line as shown. The optimum valve for this load condition and supply pressure is the 2.7 GPM size.

The Nomograph is also useful for determining, by trial and error, with a valve size given, the P_s required to fulfill a known load requirement. Also, with a valve size given, any combination of Q and P_L for a certain P_s can be determined directly. (*From 8-page bulletin, Model 410 Servovalve, which also gives formulas for analysis of hydraulic servo systems, Raymond Atchley, Inc., 2340 Sawtelle Blvd., Los Angeles 64, Calif.*)

For this literature circle **120** on inquiry card.

TRANSDUCER POWER SUPPLY

Output is isolated from line voltage and line ground in new Model 21 Isolated Power Supply for use both with

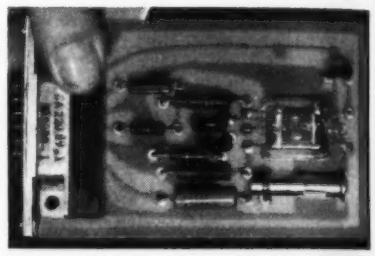


single-sided strain gauge amplifiers and differential amplifiers. Transistorized circuit provides 0-20 v at 1 amp dc regulated power.—*Electronics Div., Moeller Instrument Co., 132nd St. & 89th Ave., Richmond Hill 18, N. Y. C.*

For more information circle **121** on inquiry card.

"MATCHBOX" MODULE TUBE

New tube format for automated module and printed circuit production is designed to be supported by leads

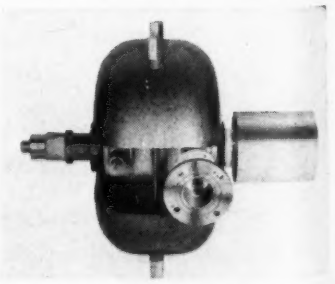


or clamped to printed circuit board for best heat transfer and vibration damping. Type WX-3608, sharp-cutoff pentode with characteristics similar to type 6AG5, is illustrated.—*Electronic Tube Div., Westinghouse Electric Corp., Elmira, N. Y.*

For more information circle **122** on inquiry card.

AMPLIFIER KLYSTRON

New 1 kw cw aircooled 4-cavity klystron continuously tunes from 1700 to 2400 mc and is focussed with a permanent magnet. Designed for for-

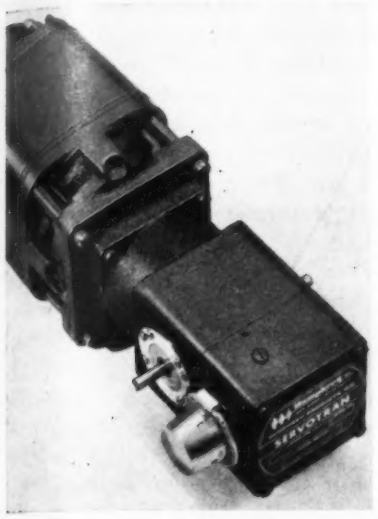


ward scatter communication systems, it combines resonant circuits with tube for high-efficiency operation with minimum of operational adjustments. —*Varian Associates, 611 Hansen Way, Palo Alto, Calif.*

For more information circle **123** on inquiry card.

VARIABLE SPEED DRIVE

New Servotran variable speed drive for motors 1/100 to 1/40 hp is only 2" square, can be provided with vernier 10-turn dial for exact speed

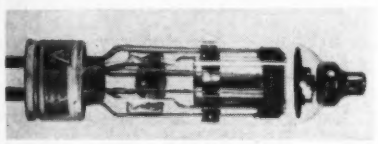


adjustment, or with quick-change lever to reverse from full forward to full back in only 0.05 seconds.—*Humphrey Prod. Div., Humphrey, Inc.*, 3794 *Rosecrans St., San Diego* 10, *Calif.*

For more information circle **124** on inquiry card.

HIGH CURRENT THYRATRON

New filament and grid design give type VTP 7386, thyratron replacement for C6J, C6JA, 5685 or 5C21,



30% more peak anode current than the older tubes. Withstands temperature extremes from −55° to 75°C.—*Vacuum Tube Products Co., Inc.*, 2020 *Short St., Oceanside, Calif.*

For more information circle **125** on inquiry card.

COOLS HOT TUBES

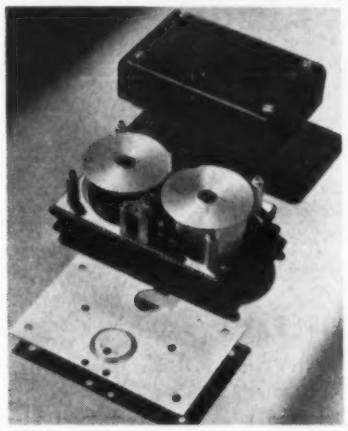
New IERC THERMA-flex liner reported in NEL Reliability Design Handbook as giving best heat dissipa-

tion in both IERC "NW" and "TR" type vacuum tube shields, reduces bare tube temperatures by more than 50% and 35% respectively. Complete information on request.—*International Electronic Research Corp.*, 145 *W. Magnolia Blvd., Burbank, Calif.*

For more information circle **126** on inquiry card.

TAPE PROGRAMMER

New Model MLP-13 13-channel tape programmer for missile guidance has 160-ft capacity for 35 mm Mylar



punched tape, giving 10.6 minute program at tape speed of 3 ips. Operates from 115 v 400 cps, weighs less than 5 lbs.—*Beattie-Coleman, Inc.*, 1000 *No. Olive St., Anaheim, Calif.*

For more information circle **127** on inquiry card.

DIGITAL DATA PRINTER

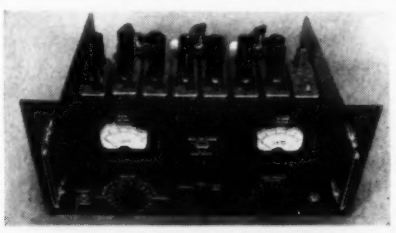
New Model 176 digital indicator and printer continuously monitors and periodically records weight, strain,

temperature and other variables measured by bridge-type transducers, on printed paper tape. Reading rates up to 2 per second.—*Gilmore Industries Inc.*, 13015 *Woodland Ave., Cleveland* 20, *Ohio.*

For more information circle **128** on inquiry card.

ANALOG DATA MULTIPLEXER

New Model 3515 Multiplexer accepts 1 to 8 Geotech FM subcarrier oscillators, couples directly to single-



voice frequency telephone, radio or microwave circuit for long-distance transmission of analog data. Bulletin TM-0581 on request.—*The Geotechnical Corp.*, 3401 *Shiloh Rd., Garland, Tex.*

For more information circle **129** on inquiry card.

LONG-RUN CAMERA

New Traid Model 805 Fototracer, with ruggedized lightweight intermittent movement, holds 1200 feet of

film for events up to 50 minutes duration. Designed for filming rocket engine tests, it operates at 16, 24, 32, and 64 fps from governor-controlled motor.—*Traid Corp.*, 17136 *Ventura Blvd., Encino, Calif.*

For more information circle **130** on inquiry card.

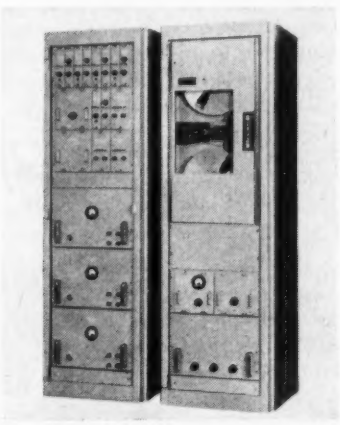
FLAC DATA RECORDER

Radar information is reduced to coded decimal form, stored in transistorized shift registers, edited to fit Florida Automatic Computer (FLAC), then gated out for writing on magnetic tape for direct entry into FLAC for data reduction. Automatically checks information written on tape against information in storage buffers to increase reliability of missile flight data.—*Technitrol Engineering Co., Philadelphia* 34, *Pa.*

For more information circle **131** on inquiry card.

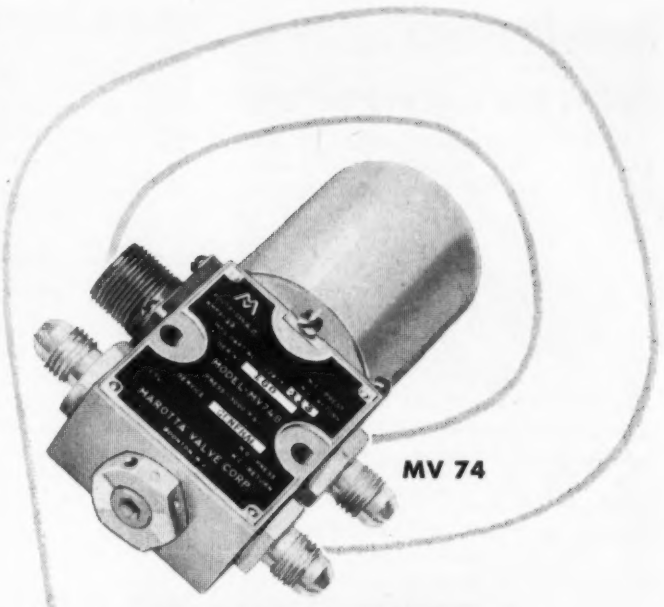
WIDE BAND DATA RECORDER

New CV-100 series instrumentation tape recorder uses ½" tape to record 7 full channels of 1 megacycle



information at 120 cps. Records 12 minutes running time with reproducible accuracy of 0.005% held by Minicom Cyclelock system.—*Mincom Div., Minnesota Mining & Mfg. Co.*, 2049 *So. Barrington Ave., Los Angeles* 25, *Calif.*

For more information circle **132** on inquiry card.



NOW!

JUST ONE SOLENOID VALVE WITH . . .

- 24 V.D.C. Power or
- 60 and 400 cycle 115 V. A.C. Power
- Fast Actuation
- Pressure ranges up to 6000 psi
- Most fluid services
- Manual overrides

for applications that require . . .

2 way normally closed
2 way normally open
3 way normally closed
3 way normally open
or shuttle operation

That's the versatile Marotta 3 way, 2 position, ¼ inch tube MV 74

Another addition to the over 300 Marotta valve models now in general use throughout industry.

PRV-11A Special 6" 160 psi LOX Pressure relief

RV-23 ¼" Pneumatic Regulator-Hand Type 50 to 4500 psi

MV-41A ⅛" N.C. 1000 psi Fuel Solenoid

RV-4 ¾" 60 psi Integral Relief Pressure Regulator

MV-36 ½" N.C. 3500 psi Internally Piloted Solenoid

Write or call for complete information.
Experienced engineers available for consultation.

Marotta VALVE CORPORATION

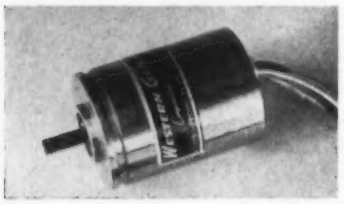
pioneer producers of high pressure valves
P. O. BOX 300-T BOONTON, N. J.

For more information circle **52** on inquiry card.

New Products—CONT.

SIZE 10 AND 11 SERVO MOTORS

New six-pole units, sizes 10 and 11, have stall torque of 0.6 oz-in minimum, no-load speed of 6500 rpm



and acceleration at stall of 42,000 radians/sec². Operate in ambients from −65° to 125°C. Available for 26, 55, or 115 v 400 cps ac or special voltages on order.—*Electro Products Div., Western Gear Corp., 132 W. Colorado St., Pasadena, Calif.*

For more information circle **133** on inquiry card.

STEP SERVO MOTOR

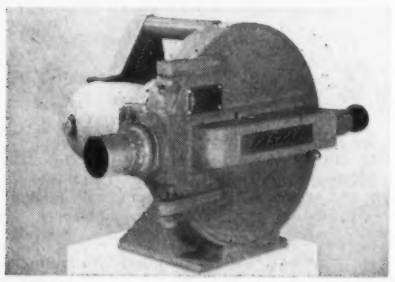
New Digital-to-Analog converter operates from dc pulses at rates from 20 to 120 pulses per second, to achieve 360° rotation in 8 steps without de-

tents. Identical in appearance with conventional servo motors, the Size 8 Step-servo motor is available in impedances of 50 to 150 ohms, for operation through 20 to 40 v dc, over a temperature range of −55° to 125°C, and meets MIL-E-5272B and MIL-E-5400.—*Induction Motors of California, 6058 Walker Ave., Maywood, Calif.*

For more information circle **134** on inquiry card.

HIGH SPEED CAMERA

New 16mm FASTAX WF-3T camera uses 2-sided continuously rotating prism synchronized with film motion to take pictures from 150 to

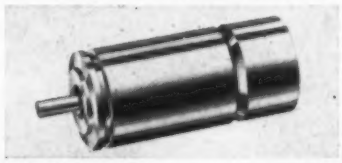


6000 frames/sec, supplementing previous models with 4-sided prism and speeds to 1,600 fps. Holds 100′ film for short duration studies.—*Wollensak Optical Co., Dept. FA-3, 850 Hudson Ave., Rochester 21, N. Y.*

For more information circle **135** on inquiry card.

INERTIA-DAMPED SERVO MOTOR

New size 8 inertia-damped servo motor Model 8 IM 460 operating from 115 v, 400 cps source is provided viscous friction damping by coupling

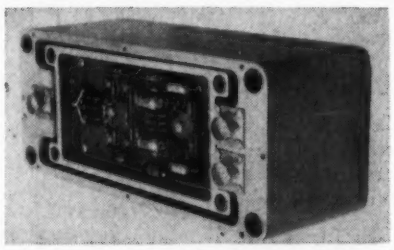


low-inertia drag cup to a freely rotating magnet flywheel. Low inertia rotor and high stall torque produce acceleration at stall of 68,000 rad/sec², attaining upper corner frequencies near 41 cps. Meets Mil environmental and vibration specifications.—*Helipot Div., Beckman Inst., Inc., Fullerton, Calif.*

For more information circle **136** on inquiry card.

HI-G ELECTROCARDIOGRAPH

Three-channel electrocardiograph input stage for use on rocket sled at Holloman AFB test track on animal

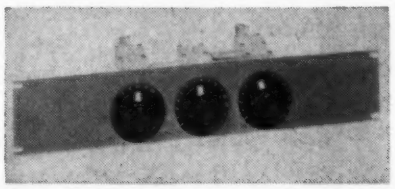


and human subjects operates in stresses up to 200 G. Frequency response, dc to 20 cps ±1%; input impedance 160,000 ohms; time constant 1.5 sec; system gain 150 with single-ended input, 300 when used differentially.—*Edin Div., Epsco, Inc., 207 Main St., Worcester 8, Mass.*

For more information circle **137** on inquiry card.

RF ATTENUATOR

New 50-ohm accurate variable step attenuators designed to operate from dc to 500 mc, are available as individual unmounted units or mounted in

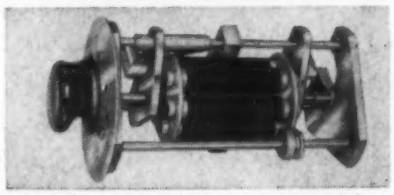


combinations up to four units on 3½" x 19" rack panels. Each resistor used is highly stabilized, is mounted in cavity which eliminates reactive components over useful frequency range of unit.—*Ortho Filter Corp., 196 Albion Ave., Paterson 2, N. J.*

For more information circle **138** on inquiry card.

COAX STEP ATTENUATORS

New variable 6-step (Model AT-108) and 12 step (Model AT-109) T-network attenuators of coaxial line construction employ deposited carbon precision resistors rated at 4 watts continuous, 2 kw peak. Attenuations from fractional db to 60 db, VSWR 1.2, and standard impedance 50 ohms,



with other impedances on special order; are listed in Catalog A-259.—*Empire Devices Prod. Corp., Amsterdam, N. Y.*

For more information circle **139** on inquiry card.

TROPOSCATTER DUPLEXER

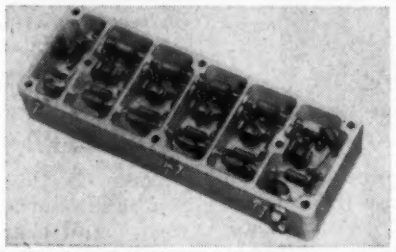
High rejection attenuation is attained by new duplexer designed for tropospheric scatter applications in

the 755 to 985 mc band. Enables single antenna to be used simultaneously for transmitting and receiving.—*D. S. Kennedy & Co., Cohasset, Mass.*

For more information circle **140** on inquiry card.

TRANSISTORIZED IF AMPL.

New Type 82D ruggedized IF amplifier for missile use withstands 30



G shock, vibration to 2000 cps and 80 G acceleration. Center frequency, 30 or 60 mc; bandwidth, 1-20 mc and gain, 80 db.—*LEL, Inc., 380 Oak St., Copiague, N. Y.*

For more information circle **141** on inquiry card.

MICROWAVE ABSORBERS

New Radite No. 75 microwave absorbing plastic is now available in

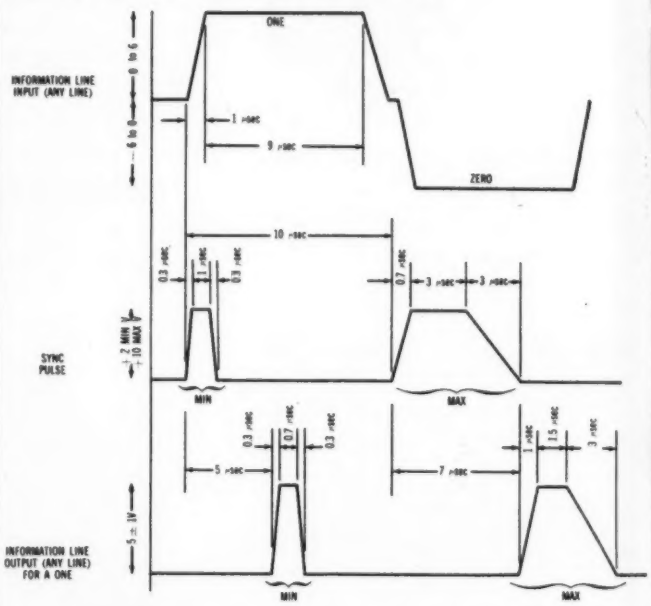
rod forms in convenient sizes for experimental fabrication. Two 4-page brochures giving design data available on request.—*Radar Design Corp., Pickard Drive, Syracuse 11, N. Y.*

For more information circle **142** on inquiry card.

Auxiliary Memory Uses Cores

Using solid-state active elements throughout—transistors, semiconductor diodes, and ferrite cores—new core storage buffers are designed for applications requiring auxiliary data storage to synchronize two systems operating at different speeds. They operate with optimum reliability from 0° to 40°C but occasional exposures to 70° temperatures will not damage the buffers nor impair their operation. They are unaffected by humidity.

Models 144-BQA (4 bits/character) and 144-BQ8A (8 bits/character) core storage buffers load and unload all bits of each character in parallel. Characters are loaded and unloaded in sequence, therefore the first character loaded is the first character unloaded. Load and unload commands are executed immediately, in the order transmitted to the buffer.



INPUT, Sync and Output pulse relationships.

LOAD—Information is presented to the buffer on parallel lines, one line per bit, in the form of d-c levels.

UNLOAD—Information is obtained from the buffer on parallel lines, one line per bit, in pulse form. Unloading occurs upon transmission of an UNLOAD SYNC pulse to the buffer.

INTERLACED LOAD AND UNLOAD—Loading and unloading operations can be intermixed in any sequence at rates up to 10,000 character/sec. For example, the Model 144-BQ8A buffer can store 73 eight-bit characters; the first 28 characters can be read out; load another 59 characters; read out the remaining 45 characters from the initial load; and then load up to 85 additional characters. Regardless of loading and unloading pattern, each operation is executed in 10 μsec.

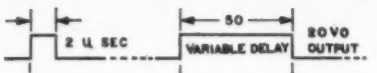
CLEAR—A pair of terminals is provided, to which shorting contacts may be connected for clearing the buffer which sets the address circuits to the initial address.—(From 2-page technical data sheet, "Core Storage Buffer," *Telemeter Magnetics Inc., 2245 Pontius Ave., Los Angeles 64, Calif.*)

For this literature circle **143** on inquiry card.

Transistor Switching Circuitry

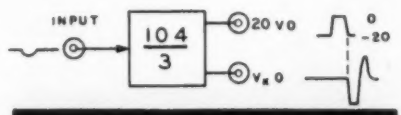
To change standard pulses—

In width,



Or delay them in time,

Or reconstruct a pulse



The 104A Pulse Delay Tri-Unit consists of three independent sections, each providing three functions: Pulse standardization, variable pulse delay, and variable square wave generation.

Specifications (each stage):

Outputs: (1) negative and positive 2.5 v, 1.5 μsec pulses; (2) positive square wave from —20 v to —0.2 v. Constant output for loads down to 500 ohms.

Input: Any negative pulse of at least 1.5 v amplitude with 1 μsec or less rise time. Temp. compensated for constant output from 50° to 135°F.

Power at 100% duty cycle: —10 v, 5 ma and —20 v, 25 ma.

(*One of 24 applications from 15-page bulletin "Notes on Transistor Switching Circuitry," Navcor Series 100, Navigation Computer Corp., 1621 Snyder Ave., Philadelphia 45, Pa.*)

For this literature circle **144** on inquiry card.

Silicon Cell is Secondary Solar Radiation Standard

Pyroheliometer standards of considerable complexity previously have been the only accurate means by which manufacturers who use or produce solar cells could gage the efficiency of the components being received or shipped. The International Rectifier Corporation, 1521 E. Grand Ave., El Segundo, Calif., has now developed a highly stable and accurately calibrated Secondary Standard Silicon Solar Cell which can be reliably substituted for the more costly laboratory method.

Each cell is selected to be of at least 9% conversion efficiency, and is accurately calibrated for various radiation intensities and at specified temperatures. The calibration curve is permanently mounted inside the instrument case lid, for convenient reference by the customer.

Standard Silicon Solar cells measure 1.87" x 1.2" x 0.28", are mounted in a shock resistant case and are protected by coated optical glass windows. Thermocouple leads for the measurement of cell temperature are attached.

Detailed instructions and data for use are contained in bulletin SR-277, which is available on request.

For this literature circle **145** on inquiry card.

For more information circle **53** on inquiry card.

For more information circle **54** on inquiry card.

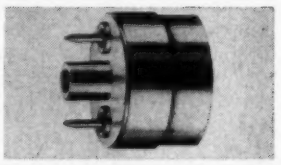
RELAY INTERLOCK

New Model 113-386 Relay Interlock contains three separate ac relays which cut off all ac power when any 115 v ac phase is reduced under 36 volts. Fourth relay maintains 28 v dc for 4-min period after ac failure then de-energizes if ac is not back to proper level; also disconnects hot ac phases if dc fails. Withstands 10 G vibrations to 500 cps, operates in 15 G, 11 msec shocks and environmental conditions including temperatures from —54°C to 71°C.—*Trio Laboratories, Inc., Plainview, L. I., N. Y.*

For more information circle **146** on inquiry card.

HIGH TEMP THERMAL SWITCH

New CPI "Button" switch, calibrated within 2°F of any value from —20° to 600°F, is available in either close-on-fall or close-on-rise contacts.



Temperature differential and repeatability for any switch is about 1°F, is mounted by lugs, soft soldered to, or recessed into controlled surface. Meets MIL-E-5272A shock and vibration specs.—*Control Products, Inc.*, 306 *Sussex St., Harrison, N. J.*

For more information circle **147** on inquiry card.

ACCELERATION SWITCH

Senses accelerations by oil-damped mass attached to cantilever beam providing operation on three modes:

NC unidirectional, NO unidirectional and NO omnidirectional. Applications in missiles, automatic aircraft warning, shock measurement and vibration shut-down actuation.—*ERA Engineering, Inc.*, 1009 *Montana Ave., Santa Monica, Calif.*

For more information circle **148** on inquiry card.

SURFACE TEMPERATURE PROBE

New surface temperature probe REC Model 116D, for measurement of skin and gas temperatures of missiles and jet engine control, features

pure platinum wire sensor and a 1/16-inch Inconel sheathed lead. The standard models upper limit of 760°C can be raised to 1100°C for many applications. Bulletin 116-24 on request.—*Rosemount Engineering Co.*, 4900 *W. 78th St., Minneapolis* 24, *Minn.*

For more information circle **149** on inquiry card.

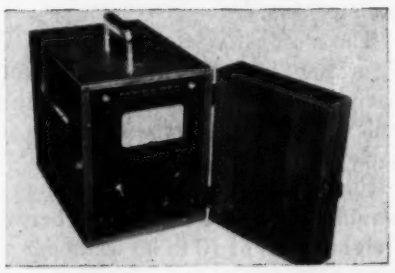
SENSITIVE MAGNETOMETER

New precision Model M-6 Magnetometer, with sensitive element sealed in plastic for field use is also used in laboratories to measure magnetic pole strengths, determine current in conductors, and inspect aircraft parts for residual magnetism.—*Irwin Laboratories, Inc.*, 1238 *So. Gerhart Ave., Los Angeles* 22, *Calif.*

For more information circle **150** on inquiry card.

FREQUENCY MODULATION METER

New Model T180 Frequency Modulation meter reads percent frequency modulation directly, also has record-



ing output for recording transients and instantaneous frequency modulation.—*Avtron Mfg., Inc.*, 10409 *Meech Ave., Cleveland* 5, *Ohio.*

For more information circle **151** on inquiry card.

Small Plate Packs up to 256 Photo-diodes per Inch

A Rex-Array, a sandwich composed of a glass plate, a layer of parallel transparent conductors, a layer of cadmium sulfide, another conductor and an epoxy coating, provides a photo-rectifier junction at each conductor crossing. Because photo-rectifier junctions are open circuits in the dark, logical networks can be arranged by selecting the required rectifiers in a Rex-Array with a light mask. Programming becomes

LIGHT MASK produced on data computer determines which rectifier junctions are activated in new photo-rectifier logic system.

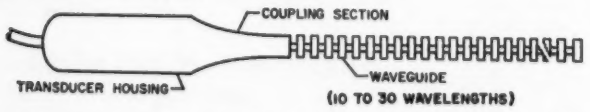
unlimited through the simple use of masking cards produced by punched data systems (See Figure).

Under illumination each cell in the Rex-Array is a diode with a rectification factor of about 600 with a forward impedance of 10K ohms and a back impedance of 6 megohms; in the dark it is an open circuit. The electrical response is approximately 1 μsec; the optional response is about 100 μsec, with its sensitivity peaking about 6500 Angstroms.—(*From 2-page catalog sheet, Electronic Components Dept., The Rex Corporation, West Acton, Mass.*)

For this literature circle **152** on inquiry card.

End-Fire Sonar Transducer

SEFAR (Sonic End-fire for Azimuth and Range) is the name given a new type of sonic transducer which is analogous to the highly directional end-fire antenna array. It consists of a driving transducer and coupling section about one wavelength long; and circularly ridged waveguide from 10 to 30 wavelengths long (See Figure). It can be adapted to conventional sonar systems, according to its developers.



Based on a theory developed by Dr. M. C. Junger, SEFAR is a product of research and development under a Naval contract accomplished by Acoustica Associates, Inc.

The most satisfactory model at 10 kc is a brass configuration 13 feet long, one inch in diameter, with a barium titanate transducer. It exhibited a directivity index of 21 db, a high efficiency and power handling capacity of over 2 kilowatts.

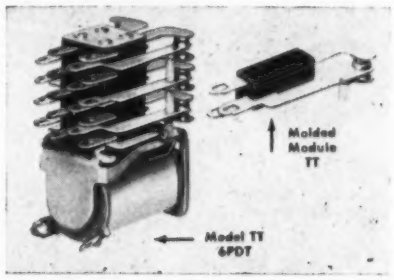
Chief advantages over other sonar transducers claimed for SEFAR are its higher efficiency, power-to-weight ratios of 10 to 30 watts per pound vs 1 watt per pound of transducer weight for older systems, and beam-width directivities from 45° to 10°.—(*From 2-page technical data bulletin, Acoustica Associates, Inc., 26 Windsor Ave., Mineola, N. Y.*)

For this literature circle **153** on inquiry card.

New Products—CONT.

RELAY SPRING MODULES

New relays with modular SPDT assemblies are available in Model TT to meet MIL-R-5757C and model TS



to meet MIL-R-6106C. Up to six modules used in each relay keep springs permanently aligned.—*Ohmite Mfg. Co., 3678 Howard St., Skokie, Ill.*

For more information circle **154** on inquiry card.

ROTARY RELAY

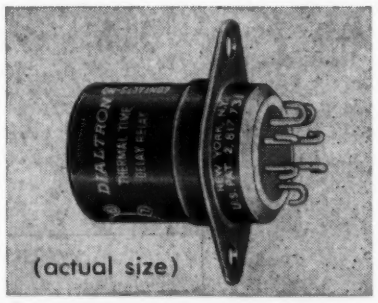
New CVE Type 4C 4PDT dc relay features operation at ambients to 125°C, in vibration to 2000 cps at 20

G acceleration; with no opening, energized or de-energized, at 75 G. 11 milliseconds duration.—*Couch Ordnance, 3 Arlington St., North Quincy, Mass.*

For more information circle **155** on inquiry card.

SUB-MINI THERMAL DELAY

High-vibration and high-temperature specifications are met by new ¾ oz hermetically sealed thermal relays



with delays of 1 to 300 sec, and compensated for temperatures from —65° to 125°C. SPST 6 amp 115v ac contacts are NO or NC.—*Dialtron Corp., 203 Harrison Pl., Brooklyn 37, N. Y.*

For more information circle **156** on inquiry card.

SEQUENCING TIMER

New Model HYS89 sequencing timer closes 26 load switches sequentially in pairs for fail-safe operation. Motor

cutoff stops switch after 90 sec., reset time is 5-10 sec. Sealed to meet MIL-specs, it operates on 115v 400 cps motor power and 20 v dc for the clutch, in —55° to 85°C ambients.—*Eagle Signal Corp., Moline, Ill.*

For more information circle **157** on inquiry card.

FREQUENCY COUNTING TIMERS

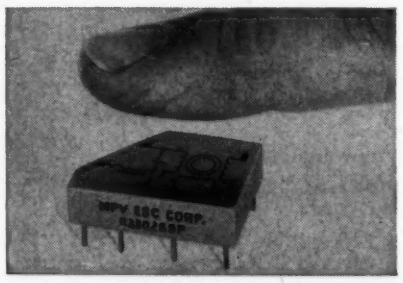
New I-L-S 1300 Series electronic tachometers and frequency counters are available in 10 models including

self-contained, remote indication, explosion-proof, and dual readout requirements. Crystal and tuningfork standards accurate to±1 count on sine wave or pulse inputs from 0 to 150,000 cps. Display time adjustable from 0.1 to 10 sec.—*I-L-S Instr. Div., The Meriam Inst. Co., 4532 W. 160th St., Cleveland 35, Ohio.*

For more information circle **158** on inquiry card.

SHIFT REGISTER

New SR-104 miniature shift register is one-core-per-binary-bit unit with 5 kc information rate and S/N ratio of 10:1. Operates over —55°

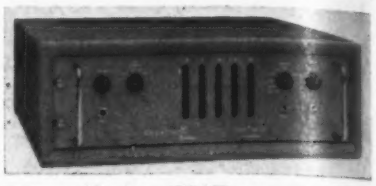


to 125°C temperature range. A 14.0 μsec, 22 v outpulse results when 10.0 μsec, 7 ma input pulse is followed by a 8.0 μsec 300 ma shift pulse.—*ESC Corporation, 534 Bergen Blvd., Palisades Park, N. J.*

For more information circle **159** on inquiry card.

FREQUENCY COUNTER

New transistorized EPUT meter measures frequencies from 10 cps to 200 kc with accuracy to 1 in 10^4



over —4° to 150°F range. 1-2-4-8 binary-coded output is available to drive data converters.—*Berkeley Div., Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, Calif.*

For more information circle **160** on inquiry card.

DIGITAL VOLTMETER

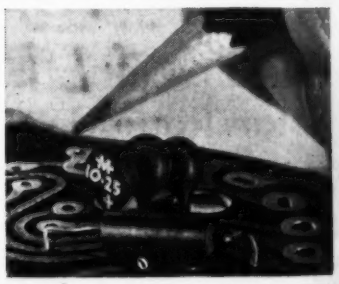
Four- and five-digit transistorized dc voltmeters using "controlled drive"

stepping switches are described in Cubic's bulletins 100-D and 101-D.—*Cubic Corp., 5575 Kearny Villa Rd., San Diego 11, Calif.*

For more information circle **161** on inquiry card.

SOLID TANTALUM CAPACITORS

New disc-shaped encapsulated solid tantalum capacitors require less sur-

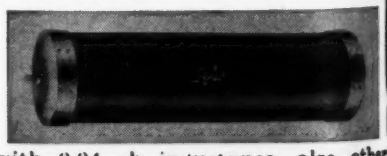


face space on printed circuits. Elimination of metal can saves 30% weight.—*P. R. Mallory & Co., Inc., Indianapolis 6, Ind.*

For more information circle **162** on inquiry card.

LOW-L CAPACITORS

Tubular low-inductance capacitors range from 0.10 μf at 150 kv with 0.10 μh inductance to 0.25 μf at 50 kv



with 0.04 μh inductance, also other ratings to customer specs. Supply high peak energy with short time constant.—*Axel Electronics Div., Axel Bros., Inc., 134-20 Jamaica Ave., Jamaica, N. Y.*

For more information circle **163** on inquiry card.

ELAPSED TIME METER

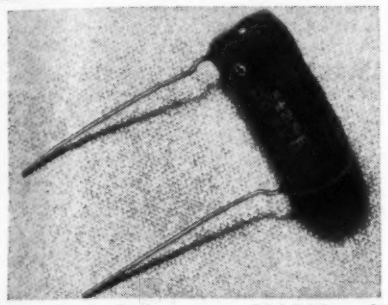
New microminiature elapsed time indicator, with jewelled gear trains uses less than 1 watt, records oper-

ation time up to 1000 hours or more on special order. Operates on 115 v, 400 cps; withstands shock and vibration for missile applications.—*Elgin Micronics Div., 366 Bluff City Blvd., Elgin, Ill.*

For more information circle **164** on inquiry card.

RUGGED CAPACITORS

New Mylar-paper Dipped Capacitors tested at 100°C at rated voltage

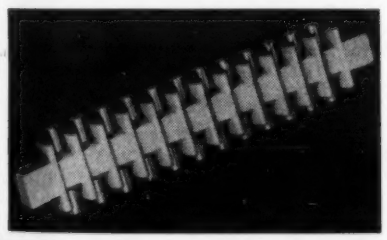


had only 1 failure per 716,800 unit-hrs for 1 mfd, exceed MIL-C-91A and MIL-C-25A.—Technical brochure available.—*Electro Motive Mfg. Co., Inc., Willimantic, Conn.*

For more information circle **165** on inquiry card.

NAVY TYPE TERMINALS

New heavy-duty terminal blocks designed by BuShips to applicable Mil-specs feature manganese-bronze

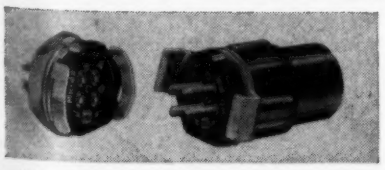


threaded studs molded in glass-filled Alkyd plastic, in different lengths and numbers of terminals. Details on request.—*Kulka Electric Corp., 633-643 So. Fulton Ave., Mount Vernon, N. Y.*

For more information circle **166** on inquiry card.

RING LOCK CONNECTOR

New MH series miniature hex connectors with 4 to 10 contacts have

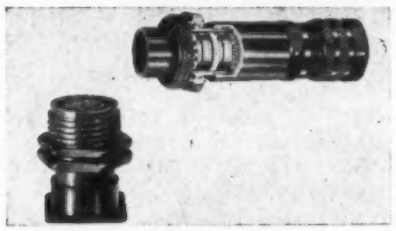


positive locking ring to withstand vibration, pulls or other in-use stresses.—*U. S. Components, Inc., 454 East 148th St., New York 55, N. Y.*

For more information circle **167** on inquiry card.

WATERTIGHT CONNECTOR

New ZZM connector uses resilient silicone insulation laminate between rigid plastic discs compressed in an

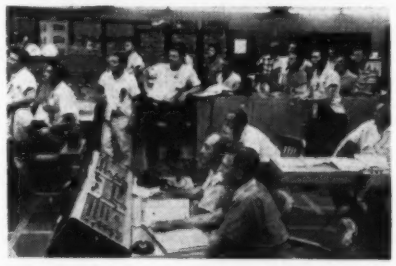


anodized aluminum shell to absorb shock and vibration, exclude moisture and hold contacts aligned. Exceeds military and NEC specifications.—*The Pyle-National Co., 1334 N. Kostner Ave., Chicago 51, Ill.*

For more information circle **168** on inquiry card.

CONTROL CONSOLES

Flexibility of combustion is shown in Atlas blockhouse installation of Emcor Enclosures Missile Control and Test facilities at AF Missile Test

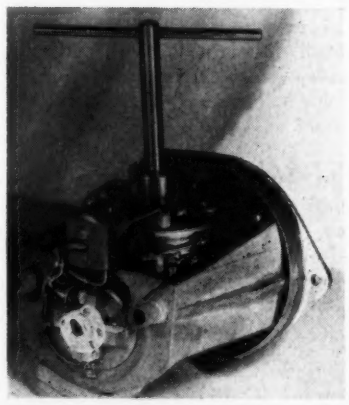


Center, Cape Canaveral, Fla. Conformation allows clear view of wall-mounted displays.—*Elgin Metalformers Corp., 630 Congdon Ave., Elgin, Ill.*

For more information circle **169** on inquiry card.

SPRING-ENERGIZED GYRO

New roll reference gyro, spring-powered to allow for indefinite storage in energized condition, needs no proving or test. Hermetically sealed, but

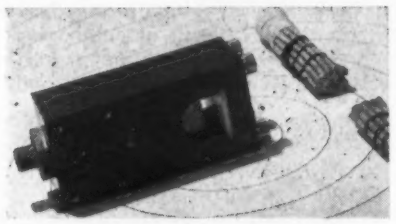


available in tape dust-seal for proving tests, the control period lasts only 30 seconds, other spring energized gyros are designed for 2 and 10 minutes flight, with minimum drift.—*Whittaker Gyro Div., Telecomputing Corp., 16217 Lindbergh St., Van Nuys, Calif.*

For more information circle **170** on inquiry card.

NON-SHORTING CABLE CUTTER

New squib-actuated guillotine cutter uses ceramic blade to drive through operating cable without shorting conductors. Designed for

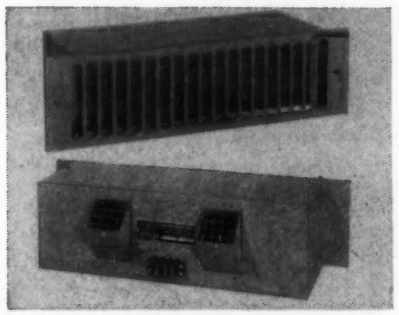


missile use to eliminate switches, connectors and relays; all circuit elements are wired to an un-activated battery. Activating battery energizes circuit; firing cutter turns it off. Other possible uses wherever no-short severing of circuits is desired.—*Beckman & Whitley, Inc., 985 E. San Carlos Ave., San Carlos, Calif.*

For more information circle **171** on inquiry card.

DUAL CENTRIFUGAL BLOWER

New quiet blower for electronic equipment fit 19" panel racks from



3½" to 8¾" high, providing from 150 to 500 cfm. Meet all important Mil-Specs, operate from 60 or 400 cps, single or 3-phase.—1959 catalog available.—*McLean Engineering Labs., Princeton, N. J.*

For more information circle **172** on inquiry card.

HIGH-TEMP POTENTIOMETER

High-temperature version of Series 42 wire-wound precision pot op-

erates up to 446°F with wattage rating of 0.25 watt. Resistance change after 255 hrs at 466°F is less than 0.1%, noise less than 5 μv.—*Clarostat Mfg. Co., Inc., Dover, N. H.*

For more information circle **173** on inquiry card.

ALLIED'S NEW Subminiature TOGGLE SWITCHES

ACTUAL SIZE

These new subminiature switches are particularly well suited to printed circuit, transistorized and other miniaturized equipment.

SPECIFICATIONS:

Handle: Ball Type Toggle
Bushing: ¼-40 Thd.
Body: Single Pole—.520 x .270 x .320 Double Pole—.520 x .520 x .320
Terminals: Gold Flashed

Contact Ratings: Low level to 5 Amp. (Res.) 115 VAC, 24 VDC
Dielectric: 1000 volts RMS
Vibration: 10-G 10-500 cps
Shock: Specification MIL-S-901 (Type C)
Endurance: 10,000 Make and Break Cycles
Tumbling: In accordance with Signal Corps Requirements
Corrosion Resistance: 50 hour Salt Spray per Federal Spec. QQ-M-151
Humidity: 10 Cycles per Specification MIL-S-3950
Seal: Low Temperature Rubber Boot for Panel Sealing is available

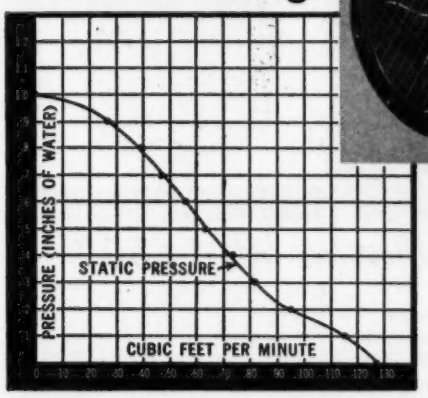
WRITE FOR BULLETIN TG

ALLIED CONTROL
MINIATURE SWITCH DIVISION OF
ALLIED CONTROL COMPANY, INC.,
2 East End Avenue, New York 21, N.Y.

AL 189

For more information circle **55** on inquiry card.

MORE THAN 3000 HOURS at 125°C ...and still running!



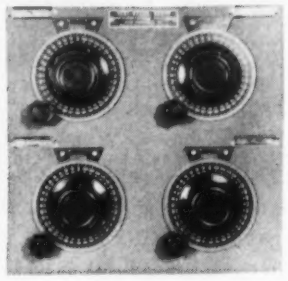
NEW Tube Axial Blower

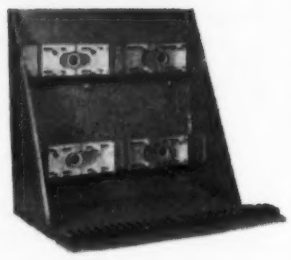
Here's a miniature tube axial blower that withstands the most rigid MIL specifications! Tests at 125°C and under extreme shock and vibration conditions, have exceeded 3000 hours, with no sign of failure. The motor is EAD's rugged, 400-cycle 208-volt induction motor, run at a constant speed of 7200 rpm. Write for complete information on this peak-performance blower assembly,

EAD EASTERN AIR DEVICES, INC.
Subsidiary of Norbute Corporation
345 CENTRAL AVE., DOVER, NEW HAMPSHIRE

For more information circle **56** on inquiry card.

SERVO TEST STAND





FRONT VIEW REAR VIEW

MODEL KID—12098/4 (JAN B-2470)

CONSTRUCTION FEATURES

- Fabricated of Aluminum Plate, Irridite Under Grey Wrinkle Paint
- Will Accept No. 8, No. 10, No. 11, No. 15 Syncro or Servo Housings
- 4" Dial Reads 0° to 360° C. W. and C. C. W. in 1° Steps
- Vernier Calibrated in 6-Minute Divisions
- Oversize Knob and Tuning Vernier Permits Precision Settings
- Fully Equipped With Housing Clamps, Card Holders, Shaft Chucks, Terminal Barrier Strips

MODEL KID—12098/4 (as illustrated) $115.00

MODEL KID—12098/1 Single Dial $49.00

PRICES F. O. B. OUR FACTORY

KUSS INDUSTRIES, INC.
Tacony and Lewis Streets
PHILADELPHIA 24, PA.

Racks and Consoles "Kuss-tom" Built to your "Specs"

For more information circle **57** on inquiry card.

rotary multipole switch

meets Specification MIL-S-6807

- *8 contact positions.*
- *Up to 6 sections, or poles.*
- *Unlimited or limited rotor movement by moving two stop screws.*
- *Electrical ratings:*
  5 amp. 28 v. d-c, resistive.
  2.5 amp. 28 v. d-c, inductive.
  2.0 amp. 28 v. d-c, lamp load.
  5.0 amp. 115 v. 400 cps, resistive. 2.0 amp. at 50% power factor.

The ESCO Type AF rotary multipole tap switch is designed to meet Specification MIL-S-6807. Rotor movement can be changed from unlimited to limited (2 to 8 positions) by placement of two stop screws in the rear plate.

Write today for Bulletin 7.

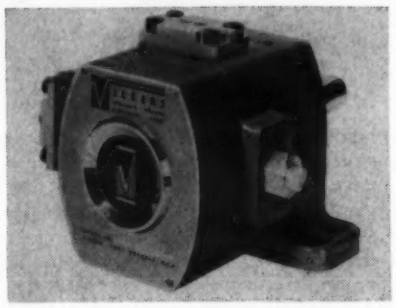
ESCO of WEYMOUTH
ELECTRO SWITCH CORPORATION
Weymouth 88, Massachusetts

For more information circle **58** on inquiry card.

New Products—CONT.

HYDRAULIC PUMP

New variable-volume vane hydraulic pump for missile ground support installations keeps volume at pre-selected pressures, eliminating valves

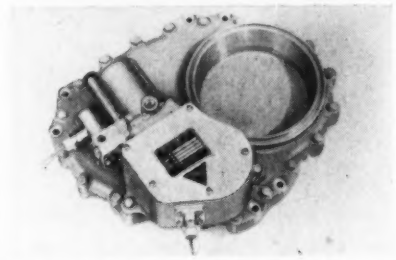


and piping normally needed to bypass oil. Rated at max volume of 5 gpm at 1,800 rpm and max pressure of 1,000 psi.—*Marine and Ordnance Dept., Vickers Inc., Waterbury 20, Conn.*

For more information circle **174** on inquiry card.

ROCKET FUEL CUT-OFF

Gate valve for standard liquid rocket fuels throttles 6" dia fuel

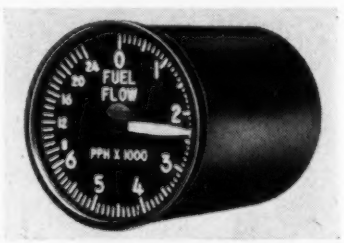


stream in 0.5 to 1.5 seconds at temperatures from −35° to 160°F, or with modifications from −320° to 250°F. Max operating pressure is 60 psig.—*Clary Dynamics, 408 Junipero St., San Gabriel, Calif.*

For more information circle **175** on inquiry card.

LIGHTED FUEL-FLOW INDICATOR

New Type 9807-04 remote station aviation fuel indicator clearly displays flow as received from MIL-T-

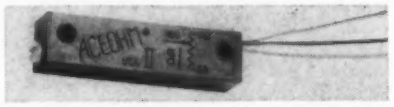


8275 fuel flow transmitter. Dial is graduated in lbs/hr x 1000; 28 v lighting in accordance MIL-L-25467A is optional.—*John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wisc.*

For more information circle **176** on inquiry card.

TRIMMER POTENTIOMETER

High-temperature, moisture-proof rectilinear trimmer ACEOHM Pot has temperature range from −55°

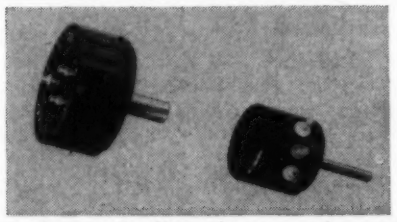


to 225°C, rated at 1.6 w @ 40°C with resolution to 0.13%. Meets MIL-E-5272a and MIL-STD 202a. Bulletin 141 on request.—*Ace Electronics Associates, 99 Dover St., Somerville 44, Mass.*

For more information circle **177** on inquiry card.

PRECISION PLASTIC POT

New conductive plastic potentiometer, is said to have made over 100 million revolutions at 2000 rpm with

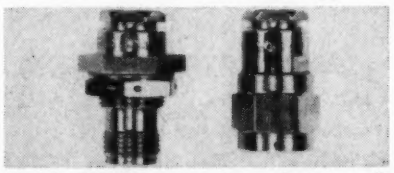


no change in linearity or noise and only 5% change in total resistance. Resistances from 50 ohm to 10 megohms, linearities to ±0.05%.—*New England Inst. Co., 320 Main St., Woonsocket, R. I.*

For more information circle **178** on inquiry card.

WIDE BAND COAXIAL CONNECTORS

New coaxial connectors KA 11-06 and KA-51-05 in TNC group, have

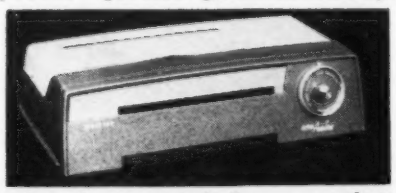


reliable VSWR of 1.25 or better, also can be calibrated at every 100 mc point in 5,000 to 11,000 mc range if desired. Meet MIL-specs; data on request.—*Kings Electronics Co., Inc., 40 Marbledale Rd., Tuckahoe, N. Y.*

For more information circle **179** on inquiry card.

COST-SAVING PHOTOCOPY UNIT

New APECO "Auto-Stat" photocopy unit using faster "COPY-QUICK" process produces multiple



copies of any typed, drawn or photographed office-sized document in 19 seconds with one sheet of paper rather than two.—*American Photocopy Equipment Co., 2100 W. Dempster St., Evanston, Ill.*

For more information circle **180** on inquiry card.

MSD new literature

SHOCK and Vibration Measuring systems are described and illustrated in new 14-page booklet.—Columbia Research Laboratories, Bullens Lane and McDade Blvd., Woodlyn, Pa.

Circle **181** on inquiry card.

VIBRATION DAMPING by surface coating, and measurement techniques used are discussed in two Technical Review articles (40 pages), on request.—B & K Instruments, Inc., 3044 West 106th St., Cleveland 11, Ohio.

Circle **182** on inquiry card.

CIRCUIT TESTING applications of DIT-MCO Analyzers, from simple sub-assemblies to complete circuits after modification and overhaul of aircraft are described in new 4-page brochure.—Dit-Mco, Inc., Electronics Div., 911 Broadway, Kansas City, Mo.

Circle **183** on inquiry card.

AUTOMATIC CHECKS of specific military electronic systems are described in 22-page booklet, "14 Men in a Box,".—Checkmate Automatic Test Equipment Co., Div. of CGS Labs., Ridgefield, Conn.

Circle **184** on inquiry card.

MEDICAL ELECTRONIC transducers to measure breathing, heart beat, body temperatures, blood pressure and skin resistance under environmental or space strains are described in new 4-page brochure.—Vibro-Ceramics Div., Gulton Industries, 212 Durham Ave., Inc., Metuchen, N. J.

Circle **185** on inquiry card.

DC ACCELEROMETER, Type A2-1100 incorporating solid-state oscillator is described in 2-page specification bulletin #110.—Wiancko Engineering Co., 255 N. Halstead, Pasadena, Calif.

Circle **186** on inquiry card.

CENTRIFUGAL SWITCH, Type C, for sequential control at selected speeds from 70 to 5000 rpm, is described in 4-page bulletin #2210.—The Eucliey Electric & Mfg. Co., Madison, Ohio

Circle **187** on inquiry card.

GYRO TESTER, LT-3783 Continuously Variable Rate Table, is described in 2-page Ground Support Equipment bulletin.—Lear Grand Rapids Div., 110 Ionia Ave., N. W., Grand Rapids 2, Mich.

Circle **188** on inquiry card.

MAGNETIC HEADS for multichannel data recording are described in 4-page brochure.—Applied Magnetics Corp., P. O. Box 425, Goleta, Calif.

Circle **189** on inquiry card.

MAGNETIC TAPE recorder for mobile military instrumentation use is described in 16-page 800B Systems bulletin.—Ampex Corporation, Instrumentation Div., 934 Charter St., Redwood City, Calif.

Circle **190** on inquiry card.

MINI MAGNETIC Tape recorders for missiles are described in new set of four 2-page bulletins.—B-J Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.

Circle **191** on inquiry card.

"PACKAGED" CLEAN rooms for precise control of contamination, temperature and humidity are described in new 4-page brochure.—Moore & Hanks Co., 9702 E. Rush St., El Monte, Calif.

Circle **192** on inquiry card.

PRESSURE GAGES used on missiles and ground support equipment are described with MIL-Specs in new 6-page folder, "Lindsay Gauges."—Rochester Mfg. Co. of Calif., 89 Beacon Place, Pasadena, Calif.

Circle **193** on inquiry card.

SOLID STATE power supply combining transistors and magnetic regulators is described in 4-page "Magnitran" catalog #114.—Electronic Research Associates, Inc., 67 Factory Pl., Cedar Grove, N. J.

Circle **194** on inquiry card.

SWITCHING TRANSISTOR. Type 2N501 High-speed Germanium, characteristics and test circuits are given in new 4-page data sheet.—Sprague Electric Co., No. Adams, Mass.

Circle **195** on inquiry card.

LOW-DRIFT Transistor, Silicon ST1026, is described in new bulletin TE-1353.—Transitron Electronic Corp., 168-182 Albion St., Wakefield, Mass.

Circle **196** on inquiry card.

TRANSISTOR/MAGNETIC Servo Amplifiers; New "B" Line 85 to 2500 watts technical data with performance specs are given in 8-page brochure.—Magnetic Amplifiers, Inc., 632 Tinton Ave., New York 55, N. Y.

Circle **197** on inquiry card.

"RELIABILITY AND COST in Printed Circuits," 15-page discussion of manufacturing considerations by Arthur C. Ansley, free on request.—Arthur Ansley Mfg. Co., New Hope, Pa.

Circle **198** on inquiry card.

"TELEMETRY GROUND Stations" is title of 5-page application bulletin 3014 showing typical systems diagrams.—Systems Div., Consoliated Electrodynamics, 300 N. Sierra Madre Villa, Pasadena, Calif.

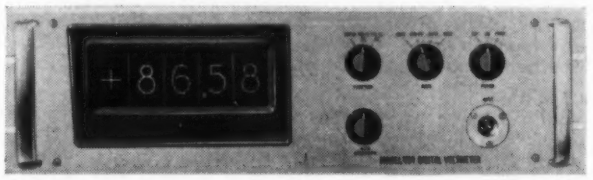
Circle **199** on inquiry card.

RADIATION METERS. 8-page bulletin, Form 3044B, describes portable radiation survey meters.—Victoreen Instrument Co., Instruments Div., 5806 Hough Ave., Cleveland 3, Ohio.

Circle **200** on inquiry card.

New Digital Voltmeter Uses Transistor Logic

Transistorized logic circuits to speed reading time, decrease stepping switch operations, and to stabilize readings on noisy or varying signals are being applied in the new V-34 digital voltmeter by Non-Linear Systems, Inc., Del Mar, Calif.



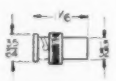
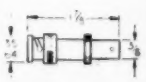
Like previous NLS instruments, Model V-34 automatically measures voltages from ± 100 microvolts to ±1000 volts with a reliable precision unequalled by conventional potentiometers. However, the new digital logic circuits control the stepping switches to arrive at a balanced reading in the fewest stepping switch operations, which enables data printing to start immediately instead of requiring a ½ second delay, as required by other stepping switch meters.

The digital principle permits linearity and accuracies to within ±0.01% of full scale reading. Also range changing and polarity indications are automatically accomplished. Voltmeter input impedance is 10 megohms, or 1000 megohms when used for voltage ratio measurements from an external voltage reference.

For more information circle **201** on inquiry card.

Coaxial Attenuators, Terminations and Transformers

Fixed pad Attenuators, terminations and impedance transformers equipped with BNC connectors are announced by Applied Research Inc.

	Attenuators		Terminations		Imped. Trans.
Model No.	HFA-50	HFA-75	HFT-50	HFT-75	HFAM
Z_{in} & Z_{out}	52.5	75	52.5	75	50/75, 50/93, 75/50[1], 75/93, 93/50, 93/75
Nom. Atten. db	1,2,3,4, 6,10,12, 15,20	2,3,6, 10,20			Min. loss
Freq. Range mcs	dc to 1000		dc to 1000		dc to 1000
Max. VSWR	1.2 at 1000 mcs				1.2 at 100 mcs
Accuracy	±½ db		±½ db		
Power Rating	½ watt		½ watt		
Temp. Range	—55° to 100°C		—55° to 100°C		
Humidity	0 to 95%		0 to 95%		
Size					

[1]First figure is male end, second is female

Also available are equivalent attenuators and terminations with type TNC connectors, and 50-ohm N-type connectors. (*From 4-page specifications brochure Applied Research Inc., 76 S. Boyles Ave., Port Washington, N. Y.*)

For this literature circle **202** on inquiry card.

ANALOG TO DIGITAL CONVERTERS
(GRAY, BINARY CODED DECIMAL)
1:1000; 1:3600; 1:216,000

For Missile and Airborne Applications

Speed and life . . . *with bi-directional read-out*
8,000 bits/min for 500 hours plus 2,400 bits/min for 1000 hours
20,000 bits/min for 300 hours plus 2,000 bits/min for 1700 hours

- Direct read-out at 20ma — 40V dc
- No brush lifting — no diodes — no networks
- Each code transfer point is unambiguously defined by a 9° least significant bit
- Passes MIL-E-5272B up to 100°C
- Ascending code—clockwise on shaft
- Synchro type mounting with pilots
- EVALUATION UNITS AVAILABLE WITHIN 30 DAYS

FOR SPECIFICATIONS SHOWN HERE, ORDER BY PART NUMBER

IDL Part Number	500206	500216	500217
Total number of bits	1000	3600 (0.1°)	216,000 (0.1')
Accuracy (Resolution)	1 bit in 1000	1 bit in 3600	1 bit in 216,000
Max/Min Torque (in. oz.)	1.5/.3	1.5/.3	3.5/.3
Bits per shaft revolution	40	40	40
Weight (incl. cables)	4.7 oz.	4.8 oz.	8 oz.
Case Length	2⅜ in.	2⅜ in.	2⅜ in.
Mounting Pilot	1.754" dia.	1.754" dia.	2.156" dia.

Other models available.

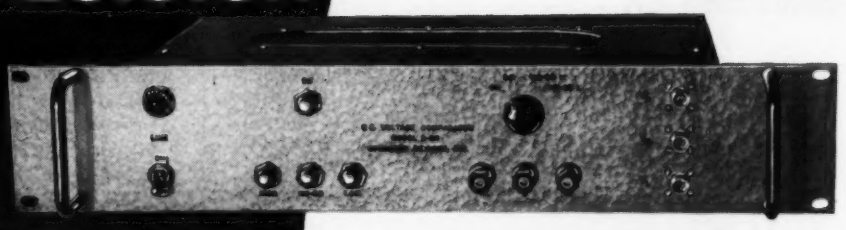
For prices and complete specifications write
INSTRUMENT DEVELOPMENT LABORATORIES, INC.
Subsidiary of Royal McBee Corporation
54 MECHANIC ST., ATTLEBORO, MASSACHUSETTS, U.S.A.

For more information circle **59** on inquiry card.

AUTOMATIC DECISION DEVICES

precision **GO**..NO-GO
voltage comparators

various models to choose from
vacuum tube or transistorized



APPLICATIONS
Automatic Go... No-Go Testing
Automatic Decision Making
Automatic Checkout
Automatic Control
Automatic Voltage Calibration

MORE SENSITIVE & PRECISE THAN METER RELAYS
Comparative sensitivity—better than 1 millivolt
Repeatability of trip point—better than 50 microvolts
Output—relay contacts for external connections

write for free "HOW-TO"
Engineering Guide to Dept. MSD1.

complete line of automatic test equipment
OPTIMIZED DEVICES, INC.
ROgers 9-6110
864 FRANKLIN AVE.
THORNWOOD, N. Y.

For more information circle **60** on inquiry card.

Photo-Copy Machine Service

A free labor and travel service to users of any and all makes of enlarging or reducing photo-copying machines has just been announced by Haloid Xerox, Inc., of Rochester 3, N. Y. This service for which the user pays only for needed parts, is one of the features of a new six-point Photocopy program which also provides: A complete line of Haloid photo-copying papers; a complete line of chemicals for use with Haloid papers; and a complete line of photo-copying machines, including the Commercial Rectigraph and the Model C Foto-Flo machines. These machines are daylight operated, semi-automatic units which utilize Simplex (coated one side) or Duplex (coated both sides) paper in roll form.

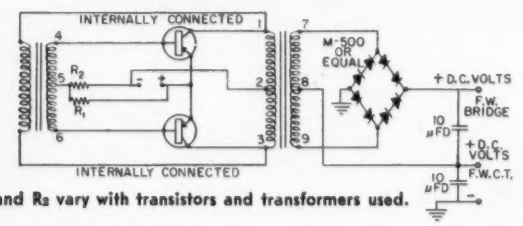
PHOTOCOPY and Xerographic research will be carried forward in this new $3½ million Research Laboratory now under construction in Webster, N. Y., as part of service-to-users program.

Free Photocopy operator training courses either on the job or at the Haloid Xerox Photocopy Training School in Rochester, N. Y.; and a program of continuing research in photo-copying methods at the new $3.5 million laboratory now under construction round out the new Haloid Xerox service program. (*From new 4-page brochure, "6 From 1," which includes directory of Haloid Branch offices.—Haloid Xerox Inc., Rochester 3, N. Y.*)

For this literature circle **203** on inquiry card.

Transistor Converter

These miniaturized high-efficiency transformers used in transistor switching circuits provide greatly improved reliability, efficiency and ruggedness, over vibrator and rotary power converters. Overall dc-to-



R_1 and R_2 vary with transistors and transformers used.

dc full load efficiencies up to 80% are attained in circuits similar to that shown. Output voltage to input of rectifier is a 800-cycle high frequency square wave permitting ease of filtering.

All transformers are hermetically sealed and constructed in accordance with MIL-T-27A Grade 4, Class R, 10,000 hr minimum life. Unique construction eliminates difficulties usually experienced with high-voltage random-wound toroidal transformers and mechanical fragility of ferrite cores.—(*From new 24-page catalog, "Miniaturized Transformers," Microtran Co., Inc., 145 E. Mineola Ave., Valley Stream, N. Y.*)

For this literature circle **204** on inquiry card.

New Literature—CONT.

MINIATURE TOROIDAL Inductors for printed circuits are described in new data sheet I8-3.—Arnold Magnetics Corp., 4613 W. Jefferson Blvd., Los Angeles 16, Calif.

Circle **205** on inquiry card.

TOROIDAL Coils, Transformers and Magnetic Amplifiers; 7 pages of application data listed in bulletins 100T and 101T.—Polyphase Instrument Co., Bridgeport, Pa.

Circle **206** on inquiry card.

PULSE TRANSFORMER and Delay Lines are listed in new 6-page catalog TR016.—The Gudeman Co., 340 W. Huron St., Chicago 10, Ill.

Circle **207** on inquiry card.

TOROID INDUCTORS, uncased, cased and encapsulated, are listed in technical bulletin KT-1.—Kelvin Electric Co., 5907 Noble Ave., Van Nuys, Calif.

Circle **208** on inquiry card.

AIRCRAFT AND TARGET displays combining Xerographic process and Charactron Shaped Beam Tube are described in 4-page SC 2000 brochure.—Stromberg-Carlson Div., General Dynamics Corp., P. O. Box 2449, San Diego 12, Calif.

Circle **209** on inquiry card.

INSERTION LOSS test set for dual channels is explained in new 8-page brochure on RF measurement, "Application Notes No. 4"—Weinschel Engineering, 10503 Metropolitan Ave., Kensington, Md.

Circle **210** on inquiry card.

MICROWAVE INSTRUMENTS and components are listed in new 16-page catalog.—Radar Design Corporation, Pickard Drive, Syracuse 11, N. Y.

Circle **211** on inquiry card.

SHAFT ANGLE Analog-to-digital encoder bulletins. Five models, from subminiature 13-digit to 16½" 18-digit size, are described.—The Baldwin Piano Co., Industrial Prod. Div., 1801 Gilbert Ave., Cincinnati 2, Ohio.

Circle **212** on inquiry card.

DIGITAL INDICATING potentiometer-voltmeter which reads any analog emf to 0.1% accuracy is described in new 4-page Milli-V-Meter bulletin.—B & H Instrument Co., Inc., 3479 W. Vickery Blvd., Fort Worth 7, Tex.

Circle **213** on inquiry card.

PUNCHED CARD MEMORY diode function generator for non-linear functions programming is described in 2-page bulletin.—Electrol, Inc., 9000 W. Pico Blvd., Los Angeles 35, Calif.

Circle **214** on inquiry card.

MILLIOHMMETER measuring to 30 μohm with 5% accuracy is described in 2-page engineering note 6-3.—Keithley Instruments, Inc., 12415 Euclid Ave., Cleveland 6, Ohio.

Circle **215** on inquiry card.

AIRBORNE COMPUTERS, infrared guidance and missile instrumentation are among capabilities described in new 12-page product brochure.—Servomechanisms, Inc., 12500 Aviation Blvd., Hawthorne, Calif.

Circle **216** on inquiry card.

SERVOS, synchros and motor generators are listed with latest characteristics in new 16 page condensed catalog.—Kearfott Company, Inc., 1500 Main Ave., Clifton, N. J.

Circle **217** on inquiry card.

SERVO nomenclature used in MIL Specs is explained in new 12-page booklet, "Rotating Servo Components".—Ketay Dept., Norden Div., United Aircraft Corp., Commack, L. I., N. Y.

Circle **218** on inquiry card.

ELECTRO-MECHANICAL drive and control components, dc and ac motors, linear and rotary actuators for military applications are listed in new Bulletin 1300.—Hoover Electric Co., Hangar 2, Port Columbus Airport, Columbus 19, Ohio.

Circle **219** on inquiry card.

ROTARY RELAYS to Rugged Mil Specs are listed in new 14-page Data Folder.—Couch Ordnance, Inc., 3 Arlington St., No. Quincy 71, Mass.

Circle **220** on inquiry card.

RELAYS, ac and dc, meeting military and commercial specs, are listed in new 4-page bulletin 59-1.—Kurman Electric Co., Brooklyn 22, New York, N. Y.

Circle **221** on inquiry card.

KLYSTRONS and TWT are described in new 12-page catalog.—Electronic Tube Div., Sperry Gyroscope Co., Great Neck, N. Y.

Circle **222** on inquiry card.

DUAL KLYSTRON universal power supply, type 812; performance characteristics given in new data sheet.—Polytechnic Research & Development Co., Inc., 202 Tillary St., Brooklyn 1, N. Y.

Circle **223** on inquiry card.

AC DRIVE MOTORS; specs of complete line are listed on data sheet.—John Oster Mfg. Co., Avionic Div., 1 Main St., Racine, Wisc.

Circle **224** on inquiry card.

SILVERED MICA Capacitor Reliability Study told in 6-page folder with graphs.—The Electromotive Mfg. Co., Inc., Willimantic, Conn.

Circle **225** on inquiry card.

PRECISION RESISTORS (Deposited Carbon) are listed and described in new 4-page "Carbon-istors" bulletin No. 101.—Kidco, Inc., 44 S. Lansdowne Ave., Lansdowne, Pa.

Circle **226** on inquiry card.

BALL BEARING conversion tables giving other manufacturers' numbers for equivalent miniature bearings; in new 4-page RMB bulletin.—Landis & Gyr Inc., 45 West 45th St., New York 36 N. Y.

Circle **227** on inquiry card.

FERRITE CORES and core product lines are described in new 4-page catalog SL-106.—Telemeter Magnetics, Inc., 2245 Pontius Ave., Los Angeles 64, Calif.

Circle **228** on inquiry card.

CABLES and plastic coated wires for military and industrial applications are listed in 6-page "Plasticote" folder.—Chester Cable Corp., Oakland Ave., Chester, N. Y.

Circle **229** on inquiry card.

CABLE, WIRE and Teflon tape in high temperature insulations are listed in 64-page 1959 Super-Temp catalog.—American Super-Temperature Wires Inc., Winooski, Vt.

Circle **230** on inquiry card.

CUSTOM CABLE design and manufacturing capabilities for specialized missile applications are discussed in 8-page folder "This is Cable Systematics."—Aero. & Inst. Div., Robertshaw-Fulton Controls Co., Santa Ana Fwy. at Euclid, Anaheim, Calif.

Circle **231** on inquiry card.

FLUID FILTRATION Cart for missile and aircraft ground support is described in bulletin No. 1381.—Geo. L. Nankervis Co., 15400 Fullerton Ave., Detroit 27, Mich.

Circle **232** on inquiry card.

FADEPROOF MARKINGS for warning and instruction plates are described in Bulletin AR-1 with Duralar sample.—Duralith Corp., 1025 Race St., Philadelphia 7, Pa.

Circle **233** on inquiry card.

CHASSIS, racks and cabinets; in new 24-page catalog.—California Chassis Co., 5445 E. Century Blvd., Lynwood, Calif.

Circle **234** on inquiry card.

METAL FABRICATION Service, including Status of Certification, is described in new 9-page facilities folder.—Farwell Metal Fabricating, 75 W. Fairfield Ave., Saint Paul 7, Minn.

Circle **235** on inquiry card.

REUSABLE PRIMARY BATTERY, Silvercel, for automatic activation described with data in new 8-page technical bulletin.—Yardney Electric Corp., 40-50 Leonard St., New York 13, N. Y.

Circle **236** on inquiry card.

TRANSPARENT SILICONE Potting Compound that permits visual and test checks of potted assembly is described in 3-page bulletin Q-3-305.—Dow Corning Corp., Midland, Mich.

Circle **237** on inquiry card.